Geotechnical Investigation Report
24 Road and G Road Improvements
City of Grand Junction, Colorado
RockSol Project No. 599.07

November 12, 2020

Prepared for:

City of Grand Junction
333 West Avenue, Building C
Grand Junction, Colorado 81501

Attention: Mr. Lee Cooper, PE

Prepared by:

RockSol
Consulting Group, Inc.

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Grand Junction, Colorado 81505
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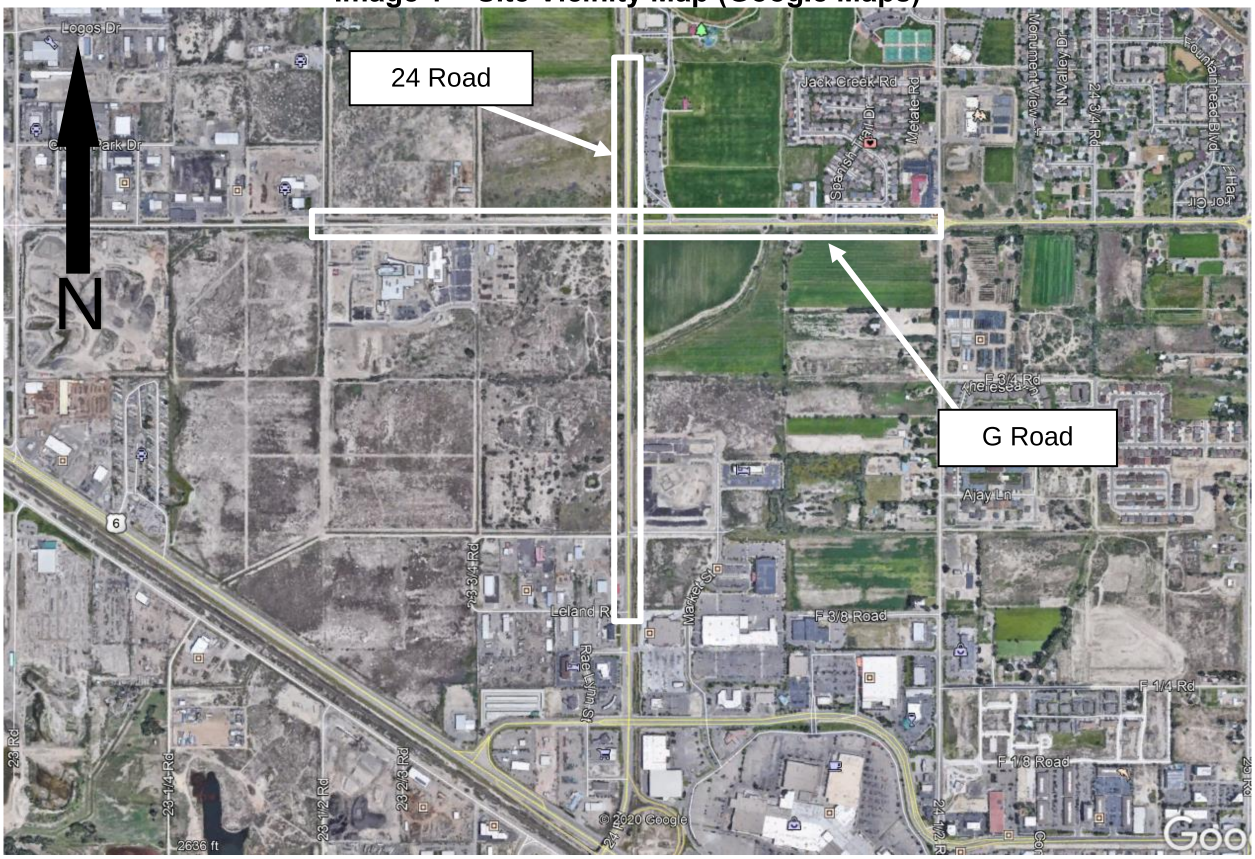
ATTACHMENTS

1.0 PROJECT OBJECTIVE AND DESCRIPTION

This report documents the geotechnical engineering investigation performed by RockSol Consulting Group, Inc. (RockSol) for the 24 Road and G Road Improvements Project in the City of Grand Junction, Colorado (see Image 1, *Site Vicinity Map*).

Image 1 – Site Vicinity Map (Google Maps)



The City of Grand Junction is planning to make improvements to the intersection of 24 Road and G Road, relocate and replace the bridge over relocated North Leach Creek and design and construct a pedestrian underpass beneath G Road (See Figure 8). A new pedestrian bridge over Leach Creek is also proposed as part of this project approximately 1,000 feet south of G Road, east of 24 Road (See Figure 7). The primary purpose of the improvements to the intersection is to add a traffic circle (roundabout) to improve traffic and pedestrian movements.

The geotechnical investigation was conducted by RockSol for the City of Grand Junction. The scope of work for this geotechnical investigation included:

- Preparing a drilling/sampling program to perform a subsurface investigation and implementing the program to collect soil samples for laboratory testing.
- Performing laboratory tests and analyzing the data.
- Preparing a report that presents the field and laboratory data obtained, geological setting and conditions, geotechnical design parameters for the proposed structures, project site improvements, and roadway pavement thickness recommendations.

Surface and groundwater hydrology, hydraulic engineering, and environmental evaluation of site soils and groundwater for possible contaminant characterization were not included in RockSol's geotechnical scope of work.

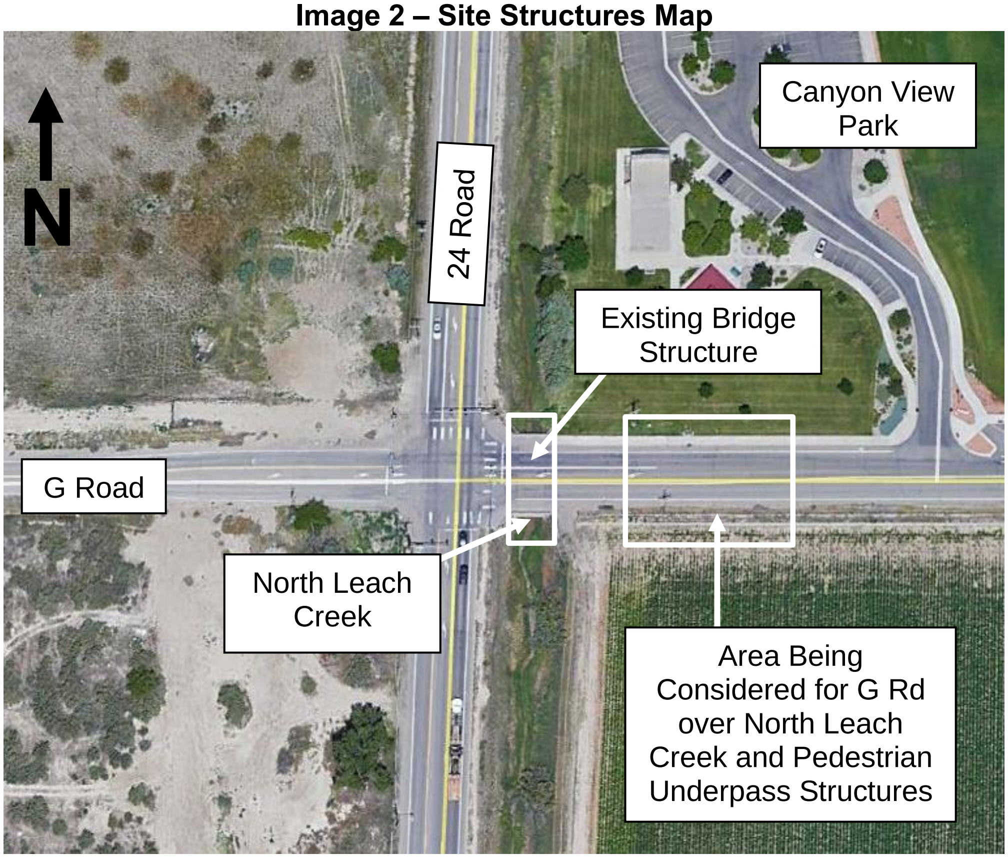
2.0 PROJECT SITE CONDITIONS

24 Road is classified as a principal arterial roadway and G Road is classified as a minor arterial roadway. A combination of farm, commercial, and undeveloped land immediately surround the project limits, with residential neighborhoods less than a half mile from the site. Canyon View Park is located east of 24 Road and north of G Road.

24 Road currently consists of three lanes, one in each direction and a center turn lane within the project vicinity. G Road consists of two lanes, one in each direction. At the intersection of 24 Road and G Road, each direction of travel has a designated left turn lane and pedestrian crossing. Both roads have shoulders on each side of varying widths. The existing lanes are approximately 12 feet wide and surfaced with asphalt pavement in all directions of travel.

Topography throughout the project limits of 24 Road and G Road consist of nearly flat slopes. North Leach Creek crosses under G Road in a north/south direction within the project limits (see Image 2) just east of 24 Road. The existing bridge structure that takes G Road traffic over North Leach Creek will be replaced as part of this project. In addition, a pedestrian crossing structure is proposed at a location approximately 250 feet east of 24 Road under G Road.

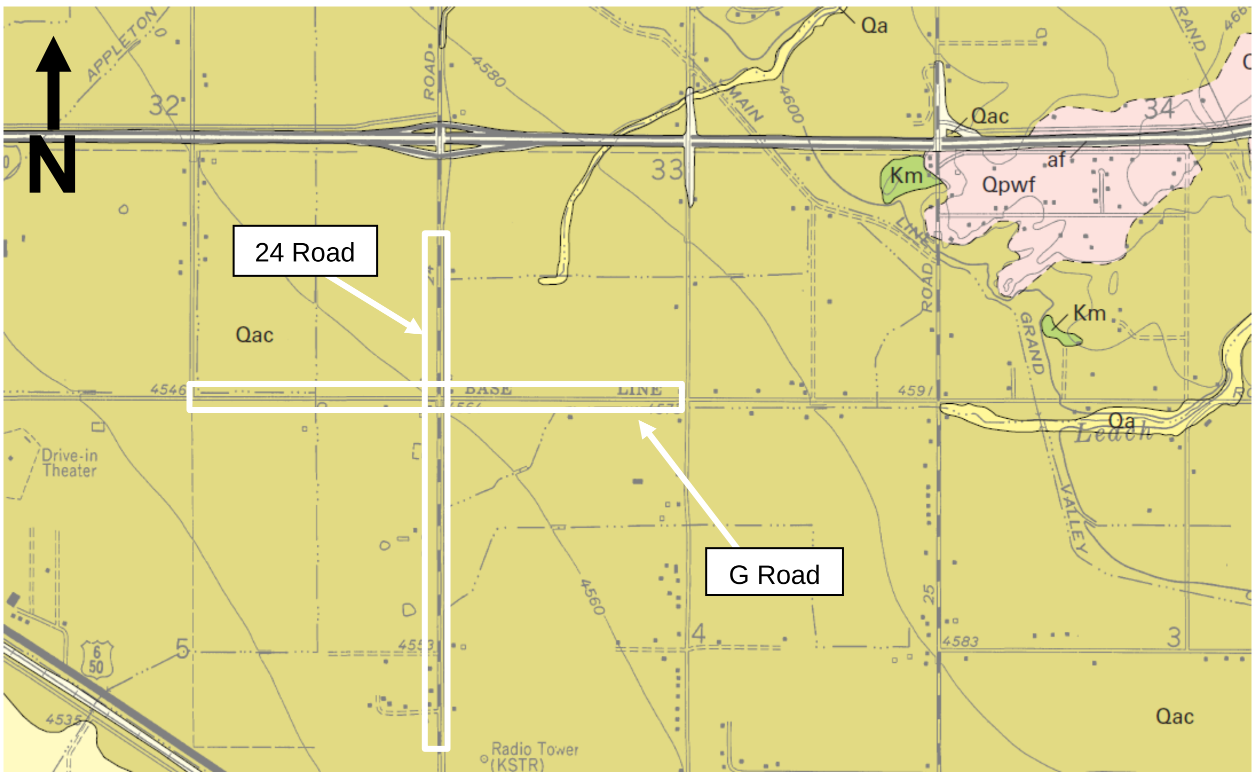
Image 2 – Site Structures Map



3.0 GEOLOGICAL CONDITIONS

Based on information presented in the United States Geological Survey (USGS) Geologic Map (See Image 3, *Site Geology Map*) of the Grand Junction Quadrangle, Mesa County, Colorado, by Roger B. Scott, Paul E. Carrara, William C. Hood, and Kyle E. Murray, dated 2002, alluvium and colluvium, undivided, (Holocene and late Pleistocene) (Qac) is mapped at the project site, as well as at the immediate surrounding areas. Alluvium generally consists of silt, sand and gravels and the colluvium generally consists of sandy silt, silty to clayey sand, and sandy clay. The materials identified by the USGS mapping was consistent with native soils encountered during our geotechnical investigation.

Image 3 – Site Geology Map (Grand Junction, Mesa County, Colorado 2002)



4.0 SUBSURFACE EXPLORATION

For this investigation, RockSol completed a total of 18 boreholes identified as 24-1 through 24-4, 24-6, 24-7, G-1, G-2, G-4 through G-6, LC-1, LC-2, T-1 through T-3, UP-1 and UP-2 (See Figures 1 through 7).

Boreholes 24-1 through 24-4, 24-6, and 24-7 were drilled along 24 Road and Boreholes G-1, G-2, G-4 through G-6 were drilled along G Road (See Figures 1 through 6). These boreholes extended to approximate depths of 5 feet to 10 feet for characterization of subsurface conditions, including groundwater depths/elevations, to assist with development of pavement thickness recommendations.

Boreholes LC-1 and LC-2 were drilled approximately 1,000 feet south of G Road and east of 24 Road on the north and south sides of Leach Creek to provide subsurface information for the proposed pedestrian bridge structure over Leach Creek (See Figure 7).

Boreholes T-1 through T-3 were drilled east of 24 Road on the north and south sides of G Road to provide subsurface information for the proposed crossing structure over relocated North Leach Creek (See Figure 3).

Boreholes UP-1 and UP-2 were drilled on the north and south sides of G Road approximately 250 feet east of 24 Road to provide subsurface information for the proposed pedestrian underpass structure and extended to approximate depths of 20 feet to 30 feet (See Figure 3).

The locations of the geotechnical investigation boreholes are summarized below in Table 4. The boreholes were drilled between June 9, 2020 and July 24, 2020. The boreholes were surveyed after drilling operations were completed by the City of Grand Junction and the survey information (surface elevations, northing, easting) was provided to RockSol.

Table 4- Borehole and Pavement Core Location Summary

Borehole ID	Borehole Location	Location
24-1	SB 24 Road	Outside Shoulder
24-2	SB 24 Road at NW corner of 24 Road and F ½ Road	Off SB Shoulder
24-3	NB 24 Road, ~1000' N of F ½ Road	Outside Shoulder
24-4	NB 24 Road	Outside Shoulder
24-6	NW corner of 24 Road and G Road	Off SB Shoulder
24-7	SB 24 Road	On inside white edge line
G-1	EB G Road	Off Shoulder
G-2	WB G Road	Outside Shoulder
G-4	EB G Road, SW corner of G Road and 24 Road	Off Shoulder
G-5	WB G Road	Off Shoulder
G-6	EB G Road	Off Shoulder
LC-1	≈1,056 ft S. of G Road & 90 ft E of 24 Rd	North side of Leach Creek
LC-2	≈1,140 ft S. of G Road & 70 ft E of 24 Rd	South side of Leach Creek
T-1	NE corner of 24 Road and G Road	Off Shoulder
T-2	SE corner of 24 Road and G Road	Within private property
T-3	NE corner of 24 Road and G Road	In park
UP-1	NE corner of 24 Road and G Road	In park
UP-2	EB G Road	Off shoulder

Boreholes were advanced with a truck mounted Simco 2800 drill rig or CME 55 track mounted drill rig using 4.25-inch outside diameter solid stem or 8-inch outside diameter hollow stem augers. The boreholes were logged in the field by a representative of RockSol with the depth to groundwater, if encountered, noted at the time of drilling. The boreholes were backfilled at the completion of drilling and groundwater level checks and patched with surface asphalt patch mix when drilled within existing pavement. A temporary piezometer well was installed at Borehole UP-2 for purposes of monitoring groundwater levels at the proposed underpass structure. The temporary piezometer well is within City of Grand Junction right-of-way (outside shoulder) of eastbound G Road.

Subsurface materials were sampled and resistance of the soil to penetration of the sampler was performed using modified California barrel and standard split spoon samplers. Penetration Tests were performed using an automatic lift system and a hammer weighing 140 pounds falling 30 inches. The modified California barrel sampler has an outside diameter of approximately 2.5

inches and an inside diameter of 2 inches. The standard split spoon sampler used had an outside diameter of 2 inches and an inside diameter of 1⅜-inches. Brass tube liners were used with the modified California barrel sampler. Brass tube liners are not used with the standard split spoon sampler.

The standard split spoon sampling method is the Standard Penetration Test (SPT) described by ASTM Method D-1586.

The modified California Barrel sampling method is similar to the SPT test with the difference being the sampler dimensions and the number of 6-inch intervals driven with the hammer per ASTM D3550. It is RockSol's experience that blow counts obtained with the modified California sampler tend to be slightly greater than a standard split spoon sampler.

Penetration resistance values (blow counts) were recorded for each sampling event. Blow counts, when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples were taken, the type of sampler used, and the blow counts that were obtained are shown on the Borehole Logs (See Appendix A).

5.0 SURFACE AND SUBSURFACE CONDITIONS

The surface and subsurface materials encountered by RockSol at our borehole locations included asphaltic pavement, road base (aggregate base course/pit run material), topsoil, fill material, native soils, and sedimentary bedrock. A brief description of the materials encountered is presented below.

5.1 Existing Asphalt Pavement Sections

Asphalt pavement was encountered in Boreholes 24-1, 24-3, 24-4, 24-7, and G-2. Asphalt pavement ranged in thickness from 3 to 15 inches.

Road base or aggregate base course (ABC) was noted at the ground surface in Boreholes 24-2, 24-6, G-1, and G-4 and ranged in thickness from 4 to 18 inches. A summary of existing pavement section thickness encountered at each borehole location is presented in Table 5.1. Pavement section thicknesses are also shown on the individual borehole logs in Appendix A.

Table 5.1 – Existing Pavement Sections

Borehole ID	Pavement Type	Pavement Thickness (in)	ABC Thickness (in)
24-1	HMA	8	NE
24-2	Road Base	NE	12
24-3	HMA	8	21.5
24-4	HMA	8.5	3.5
24-6	Road Base	NE	6
24-7	HMA	15	NE
G-1	ABC	NE	18
G-2	HMA	3	9
G-4	Road Base	NE	4

HMA = Hot Mix Asphalt; ABC = Aggregate Base Course; NE = Not Encountered

5.2 Fill Material

Fill material was encountered in boreholes 24-1, 24-3, 24-4, 24-6, 24-7, G-4 through G-6, T-1, and UP-1, and extended to depths ranging from 1 foot to 5 feet below existing grades. Fill material generally consisted of loose to dense, brown to brownish gray and black, slightly moist to moist, slightly silty and gravelly sand and sandy gravel with cobbles and clay lenses in parts.

5.3 Native Subgrade Soils

With the exception of 24-1 and G-5, native soils were encountered in all boreholes and extended to depths ranging from 5 feet (maximum depth drilled) within the pavement boreholes and to 53 feet below existing grades in the structure boreholes. Native soils encountered generally consisted of varying layers of hard to very loose, light brown to brownish gray, moist to wet, occasionally calcareous, silty to clayey sand with gravel and sandy silt in parts, and medium stiff, brown to brownish gray, moist, sandy to silty clay with iron staining in parts. The native soils encountered by RockSol are generally consistent with the alluvium and colluvium materials identified on the USGS Geological Map (See Image 3 – *Site Geology Map)* found in Section 3.0 of this report.

5.4 Sedimentary Bedrock

Sedimentary bedrock was encountered at borehole locations LC-1, LC-2, T-1, T-2 and T-3 at approximate depths ranging from 44 feet to 53 feet below existing grades (elevations ranging from 4,512 feet and 4,521 feet). Bedrock encountered consisted of very hard, dark gray, moist claystone and shale. See Table 5.2, *Approximate Bedrock Depth and Elevation* for approximate depths and elevations to bedrock.

Table 5.2 – Approximate Bedrock Depth and Elevation

Borehole I.D.	Bedrock Depth (Feet)	Bedrock Elevation (Feet)
LC-1	46	4,515.7
LC-2	44	4,516.1
T-1	46	4,521.4
T-2	53	4,512.7
T-3	53	4,513.5

5.5 Groundwater

Groundwater was encountered during drilling/sampling activities at borehole locations 24-4, G-4, LC-1, LC-2, T-1 through T-3, UP-1, and UP-2 at approximate depths ranging from 4 feet to 14 feet below existing grade at the time of drilling operations. See Table 5.3, *Approximate Groundwater Depths and Elevations* for approximate depths and elevations to groundwater, where encountered. The boreholes were backfilled at the completion of drilling/sampling operations except at Borehole UP-2 were a temporary monitoring well was installed to an approximate depth of 15 feet below existing grade for groundwater level monitoring for the proposed underpass structure.

Table 5.3 – Approximate Groundwater Depths and Elevations

Borehole I.D.	Ground Surface Elevation (Feet)	Groundwater Depth (Feet)	Groundwater Elevation (Feet)
24-1	4,553.7	NE	NE
24-2	4,554.1	NE	NE
24-3	4,559.0	NE	NE
24-4	4,562.0	4	4,558.0
24-6	4,566.0	NE	NE
24-7	4,571.8	NE	NE
G-1	4,574.8	NE	NE
G-2	4,571.2	NE	NE
G-4	4,565.3	4	4,561.3

Table 5.3 – Approximate Groundwater Depths and Elevations (Continued)

Borehole I.D.	Ground Surface Elevation (Feet)	Groundwater Depth (Feet)	Groundwater Elevation (Feet)
G-5	4,555.5	NE	NE
G-6	4,548.7	NE	NE
LC-1	4,561.7	11.5	4,550.2
LC-2	4,560.2	14.0	4,546.2
T-1	4,567.4	9	4,558.4
T-2	4,565.7	8	4,557.7
T-3	4,566.5	8	4,558.5
UP-1	4,567.0	7	4,560.0
UP-2	4,566.2	9 (during drilling) and 6 (≈ 06/15/2020)	4,557.2 and 4,560.2

NE = Not Encountered to the depth drilled

Groundwater elevations are subject to change depending on climatic conditions, water flows in North Leach Creek and Leach Creek, local irrigation practices, changes in local topography, and changes in surface storm water management. Long-term monitoring of groundwater elevations is required to establish groundwater fluctuations.

6.0 LABORATORY TESTING

Soil samples retrieved from the borehole locations were examined by the project geotechnical engineer in the RockSol laboratory. Selected samples were tested and classified per the Unified Soil Classification System (USCS). The following laboratory tests were performed in accordance with the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and current local practices:

- Natural Moisture Content (ASTM D-2216)
- Percent Passing No. 200 Sieve (ASTM D-1140)
- Liquid and Plastic Limits (ASTM D-4318)
- Dry Density (ASTM D-2937)
- Gradation (ASTM D 6913)
- Water-Soluble Sulfates (CDOT CP-L 2103)
- Water-Soluble Chloride Content (AASHTO T291-91)

- Standard Test Method for pH of Soils (ASTM D4972-01)
- Soil Resistivity (ASTM G187 - Soil Box)
- Soil Classification (ASTM D-2487, ASTM D-2488, and AASHTO M145)
- Swell Test (ASTM D-4546)
- Resistance Value (AASHTO T-190)

R-Values (Resistance Values) were tested by Cesare, Inc. All other laboratory tests were performed by RockSol. Laboratory test results are presented in Appendix B and are also summarized on the Borehole Logs presented in Appendix A.

7.0 SUBGRADE CHARACTERIZATION

Laboratory test results were used to characterize the engineering properties of the subsurface material encountered. For soil classification, RockSol conducted sieve analyses and Atterberg Limits tests. RockSol assigned R-Value testing based on the results of the soil classifications. Swell tests were used to determine the swell or consolidation characteristics of the subsurface materials. Lab testing was also performed on selected samples to determine the water-soluble sulfate content of subsurface materials to assist with cement type recommendations. A summary of the physical and chemical test results is included in Appendix B.

7.1 Roadway Subgrade Soil Classification

Subgrade bulk samples of existing roadway grades were obtained at various depths from each pavement borehole location and were tested for AASHTO soil classification. The subgrade soils tested varied between A-1 and A-4 AASHTO soil types. A summary of the roadway subgrade soil classifications is presented in Table 7.1.

Table 7.1 – Roadway Subgrade Soil Classifications

Borehole Location	Depth (feet)	AASHTO Classification
24-1	0.67-4	A-1-b (0)
24-2	1-4	A-6 (9)
24-3	0.67-2.5	A-1-b (0)
24-4	0.71-2	A-1-b (0)
24-6	0-4	A-4 (4)
24-7	1.25-3.5	A-1-a (0)
G-1	1.5-7	A-4 (0)
G-2	2.1-7	A-4 (0)
G-5	0-4	A-1-a (0)
G-6	0-4	A-4 (0)

7.2 Swell/Consolidation Potential of Subgrade Soils

Based on swell test results and plasticity index (PI) testing, the subgrade soils encountered within the upper 4 feet of the pavement surface of 24 Road and G Road exhibit low swell potential and low to moderate consolidation potential (-1.1 percent consolidation to 0.7 percent swell under 200 pounds per square foot (psf) surcharge pressure). Tests performed on samples obtained from Boreholes LC-1, LC-2, T-1, T-2, and T-3 for the proposed structures exhibited -2.4 to 0.4 percent swell.

Based on the swell test results and subgrade soil classifications obtained, special mitigation methods for expansive soil are not deemed necessary for new pavement construction or for the proposed G

Road over North Leach Creek structure (bridge and abutment walls), pedestrian underpass structure, and pedestrian bridge structure.

However, based on consolidation and penetration data obtained from the boreholes drilled, special mitigation is recommended for design and construction of shallow foundation systems being considered (See Section 9) due to settlement potential and constructability. Mitigation may consist of over excavation and replacement with coarse, granular material with geosynthetic fabrics and geogrids to help stabilize shallow foundation soils.

7.3 Water-Soluble Sulfate Content

Cementitious material requirements for concrete in contact with site soils or groundwater is typically based on the percentage of water-soluble sulfate. Mix design requirements for concrete exposed to water-soluble sulfates in soils or water is considered by CDOT as shown in Table 7.3a and in the CDOT Standard Specifications for Road and Bridge Construction, dated 2019. Water-soluble Sulfate Testing Results are summarized in Table 7.3b.

Table 7.3a – Requirements to Protect Against Damage to Concrete by Sulfate Attack from External Sources of Sulfate

Severity of Sulfate Exposure	Water-Soluble Sulfate (SO_4), in dry soil, percent	Sulfate (SO_4), in water, ppm	Water Cementitious Ratio, Maximum	Cementitious Material Requirements
Class 0	0.00 to 0.10	0 to 150	0.45	Class 0
Class 1	0.11 to 0.20	151 to 1,500	0.45	Class 1
Class 2	0.21 to 2.0	1,501 to 10,000	0.45	Class 2
Class 3	2.01 or greater	10,001 or greater	0.40	Class 3

Table 7.3b – Water-Soluble Sulfate Testing Summary

Borehole I.D.	Sample Depth (Feet)	Water-Soluble Sulfate (SO_4) in dry soil, percent	Cementitious Material Requirements
24-1	0.67 – 4	0.43	Class 2
24-2	1 – 4	0.32	Class 2
24-3	0.67 – 2.5	0.29	Class 2
24-3	2.5 – 4	0.08	Class 0
24-4	0.71 – 2	0.26	Class 2
24-4	2.1 – 4	0.37	Class 2
24-6	0 – 4	0.72	Class 2
24-7	1.25 – 3.5	1.38	Class 2
G-1	1.5 – 7	0.76	Class 2
G-2	2.1 – 7	0.40	Class 2
G-5	0 – 4	0.49	Class 2
G-6	0 – 4	0.40	Class 2
LC-1	48	0.45	Class 2
LC-2	2	1.32	Class 2
LC-2	9	0.12	Class 1
T-1	0 – 4	0.40	Class 2
T-1	24	0.13	Class 1
T-2	9	0.08	Class 0
T-2	60	0.33	Class 2
T-3	53 – 72	0.24	Class 2
UP-1	9	0.45	Class 2
UP-2	0 – 4	0.40	Class 2
UP-2	4	0.36	Class 2

The concentration of water-soluble sulfates measured in soil samples obtained from RockSol's exploratory boreholes ranged from 0.08 percent to 1.38 percent by weight. Based on the results of the water-soluble sulfate testing, concrete in contact with subgrade materials may be constructed with cement meeting the requirements for CDOT Exposure Class 2. Concrete constructed with ASTM C150 Type II, III, or V cement is appropriate for Class 2 requirements.

8.0 G ROAD OVER NORTH LEACH CREEK CROSSING FOUNDATION RECOMMENDATIONS

As part of the proposed roundabout at the intersection of G Road and 24 Road, North Leach Creek is proposed to be relocated east of its present alignment and a new crossing structure over North Leach Creek will be constructed. The North Leach Creek crossing is feasible using a bridge structure or four-sided concrete box culvert (CBC). Recommendations for both structure types are presented below.

The sedimentary bedrock encountered in the RockSol boreholes is considered suitable bearing material for supporting heavily loaded structures such as the proposed G Road bridge structure over North Leach Creek. Drilled shafts (caisson) and driven steel H-piles are feasible foundation systems for the proposed bridge structure and retaining wall abutments. Geotechnical design parameters for the deep foundation geotechnical parameters are presented in Sections 8.1 and 8.2. Due to the presence of soft to very soft subsurface soil conditions, deep foundation systems are recommended for retaining wall/wing wall structures at the bridge abutments.

A CBC structure is also feasible for the proposed G Road crossing of North Leach Creek. However, due to the presence of soft to very soft subsurface soil and groundwater conditions, ground improvement is recommended. Construction of the CBC will require excavations extend below groundwater elevations, therefore dewatering and control of groundwater during construction should be anticipated. A discussion of ground improvement mitigation for a shallow foundation system is presented in Section 8.3.

8.1 Drilled Shaft Foundation System

Drilled shafts will provide support by embedment into sedimentary bedrock. Based on the subsurface conditions encountered, it is anticipated that very hard claystone/shale bedrock will be encountered at an approximate elevation 4,513 feet.

Based on our evaluation, recommended nominal (unfactored) base resistance and nominal (unfactored) side resistance values for the bedrock material are presented in Table 8.1 for use with Load and Resistance Factor Design (LRFD) methods.

Table 8.1: Base and Side Resistance Values for Drilled Shafts in Bedrock

Bridge at G Road Over North Leach Creek	Estimated Bedrock Elevation at Borehole (feet)	Ultimate (Nominal) Resistance (LRFD)		Service Resistance (LRFD)	
		Base (ksf)	Side (ksf)	Bearing (ksf)	Side (ksf)
South Abutment	4,513.5 (T-2)	138	11.3	47	3.8
North Abutment	4,512.7 (T-3)				

The side resistance is applicable to the portion of the shaft embedded in competent bedrock. When evaluating the side resistance of the drilled shaft, the lower 1.0-diameter length above the shaft tip should be ignored. Side resistance in the soil zone above competent bedrock should be neglected when calculating axial resistance. For LRFD strength limit state evaluation, a resistance factor of 0.55 is recommended for base/ tip resistance and a resistance factor of 0.60 is recommended for side resistance evaluation for redundant single shafts. Per AASHTO LRFD (Section 10.5.5.2.4) the resistance factors for base/tip and side resistance should be reduced by 20 percent for non-redundant single shafts.

For axial bearing, a minimum shaft embedment into bedrock of 5 feet is recommended.

Drilled shaft diameters shall be sufficient to satisfy axial, bending, and lateral load resistance requirements. In addition, the shaft diameters shall be sufficient to allow for use of casing, if required, and placement of reinforcement with adequate concrete cover.

Additional design and construction considerations for drilled shafts are presented below.

(a) The construction of the drilled shafts should follow the guidelines specified in the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 503, 2019."

(b) During construction of drilled shafts, casing or slurry methods may be required to support the excavation where holes are unstable due to soil and groundwater conditions. Groundwater was encountered in Boreholes (T-1 through T-3) at an approximate depth of 8 feet (approximate elevation of 4,558 feet) below the existing ground surface during drilling operations.

(c) Prior to the placement of the concrete, the drilled shaft excavation, including the bottom, should be cleaned of all loose material. For wet conditions (more than two inches of water), concrete placement by "tremie" methods should be used.

(d) Lateral load capacity of the drilled shafts should be evaluated. Geotechnical parameters for evaluation of lateral load capacity are provided in Table 8.2.3.

(e) Drilled shafts should be constructed with spacing at least four shaft diameters center to center. For closely spaced drilled shafts, the axial and lateral capacities should be appropriately reduced. Group action of drilled shafts should be analyzed on an individual basis to assess the appropriate reduction.

8.2 Driven Pile Foundation System

Alternatively, the G Road bridge structure over North Leach Creek and abutment retaining wall structures may be supported on driven steel H-piles (Grade 50 steel). RockSol recommends the piles be driven to practical refusal in the bedrock. If significant penetration into bedrock (greater than 5 feet) is necessary for lateral resistance requirements, pre-drilling may be required. For the LRFD method, a nominal (ultimate) geotechnical capacity of 36 ksi, based on the cross-section area of the pile, can be used for Grade 50 steel.

During construction, pile driving shall be monitored per CDOT requirements per Section 502 of the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), 2019". Monitoring shall be conducted using a Pile Driving Analyzer (PDA) to determine the condition of the pile, the efficiency of the hammer and the static bearing capacity of the pile, and to establish the pile driving criteria. A resistance factor of 0.65 is recommended for LRFD strength limit state design for axial compression provided PDA testing is performed.

Additional design and construction considerations for driven piles are presented below.

(a) Steel piling, pile driving equipment, and installation of the driven steel H-piles should follow the guidelines specified in "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 502, 2019".

(b) Lateral load parameters presented in Table 8.2.1 may be used for lateral load analysis. Battered piles may be used to resist the lateral loads. The battered piles inclination should be within one (1) horizontal to four (4) vertical.

(c) RockSol anticipates that 3 to 5 feet of pile penetration into bedrock will be required to achieve capacity. The actual length of the piles should be determined during installation.

(d) Center to center pile spacing should not be less than 30 inches or 2.5 pile diameters. For evaluation of horizontal pile foundation movement, the effects of group interaction shall be evaluated in accordance with AASHTO LRFD Bridge Design Specifications, Section 10.7.2.4.

(e) Pile tips should be protected against damage using driving shoes during penetration into the sedimentary bedrock.

(f) Potential damage to adjacent properties or structures during pile installation due to noise and vibrations should be considered and evaluated, if necessary.

Lateral Resistance Parameters (Drilled Shaft and Driven Pile Foundations)

Recommended preliminary lateral resistance parameters for drilled shafts and driven piles constructed are presented in Table 8.2.1. The parameters listed are for use with LPILE® or equivalent software.

Table 8.2.1: Drilled Shaft and Driven Pile Lateral Resistance Parameters

Borehole Material	L-Pile Soil Type	Undrained Shear Strength (psf)	Angle of Internal Friction (degrees)	Subgrade Reaction Coefficient (pci)	Strain Factor ε_{50} (%)	Unit Weight (pcf)
CLAY, silty to sandy, above water table	Stiff clay w/o free water	500	0	500	0.015	125 (Total)
CLAY, silty to sandy, below water table	Stiff clay w/ free water	250	0	100	0.025	63 (Submerged)
GRAVEL, silty to sandy, Below water table	Sand	0	34	60	--	63 (Submerged)
Claystone/Shale Bedrock	Stiff clay w/o free water	8,000	0	2,000	0.004	125 (Total)

Total unit weight indicated in the table above includes soil plus moisture content. Depths at which groundwater were encountered are indicated on the attached borehole logs.

Lateral Earth Pressure Parameters (Bridge Abutments and Wing Walls)

To assist with design of bridge abutments, lateral earth pressure parameters are presented in Table 8.2.2 for the existing soils encountered. Also included are parameters for CDOT Class 1 Structure backfill material.

Table 8.2.2: Lateral Earth Pressure Parameters

Soil Type	Total Unit Weight (γ) pcf	Effective Friction Angle, ϕ′ (degrees)	Cohesion (psf)	Lateral Earth Pressure Coefficients (Notes 1 and 2)		
				Active (k_a)	At-Rest (k_o)	Passive (k_p) (Note 3)
CDOT Class 1 Structure Backfill (CDOT Section 703.08)	125	34	0	0.28	0.44	3.54
CLAY, silty to sandy	125	0	500	0.46	0.63	2.20

Note 1: Based on Coloumb Theory of earth pressure
Note 2: For horizontal backslope and foreslope.
Note 3: Full value, no reduction applied.

8.3 CBC Structure Recommendations with Ground Improvement

Boreholes T-1 through T-3 were advanced at the approximate location of the proposed North Leach Creek CBC structure. RockSol considers a design groundwater elevation of 4,557 feet appropriate for this location. Construction of the CBC will require excavations extend below groundwater elevations, therefore dewatering and control of groundwater during construction should be anticipated.

Based on conditions encountered in RockSol Boreholes T-1 through T-3, ground improvement is recommended to achieve a service bearing resistance greater than 750 psf for a 4-sided CBC system.

At a minimum, RockSol recommends ground improvement consisting of overexcavation of subgrade soils to a minimum depth of 2 feet below the bottom of the CBC bottom slab and replacement with at least 2-feet of a crushed aggregate material meeting CDOT No. 57 Concrete Aggregate which is fully wrapped with a CDOT approved Class 1 stabilization/separator geotextile placed at 6-inch intervals. The crushed aggregate and geotextile shall extend horizontally beyond the limits of the CBC a minimum of 5 feet in each direction (north/south and east/west). Placement of the aggregate material should be in horizonal lifts with a maximum lift thickness of 6 inches. Compaction of each lift with vibratory methods using lightweight equipment is recommended. RockSol recommends placement of at least 6-inches of CDOT Class 1 Structural Fill between the top of the geotextile wrapped granular material and the bottom of the foundation.

With two feet (vertically) of aggregate materials, RockSol considers a service bearing resistance of 1.0 ksf appropriate. If greater service bearing resistance is required, additional thickness of replaced subgrade soil is required. Bearing resistances, based on replacement thicknesses of aggregate is presented in Table 8.3.

Table 8.3 - Bearing Resistances for Shallow Foundations After Ground Improvement

Overexcavation And Replacement Thickness (No. 57 Material)	Strength Limit State (LRFD)		Service Limit State (LRFD)
	Ultimate (Nominal) Resistance (ksf)	Factored Resistance (ksf)	Service Bearing Resistance (LRFD) (ksf)
2 feet	4.6	2.1	1.0
3 feet	5.9	2.6	1.5
4 feet	7.7	3.4	2.0

A resistance factor of 0.45 is used to determine the factored bearing resistance for LRFD strength limit state evaluation. Service limit state, service bearing resistance is estimated to correspond to a total settlement of less than 1-inch. RockSol assumes a minimum foundation width of 6 feet for the CBC.

A representative of the geotechnical engineer should observe all foundation excavations prior to placement of the geotextile and aggregate material.

9.0 G ROAD PEDESTRIAN UNDERPASS FOUNDATION RECOMMENDATIONS

A pedestrian underpass is being considered adjacent to the new G Road over North Leach Creek bridge or CBC structure. The underpass would allow for approximately 8 feet to 10 feet of clearance for pedestrians. The bottom of the underpass would likely be approximately 12 feet below the top of pavement on G Road. The bottom of the underpass would be at an approximate elevation of 4,554 feet, which will be approximately 6 feet below the groundwater elevation.

A four-sided concrete box culvert (CBC) structure is feasible for the proposed pedestrian underpass structure. However, due to the presence of soft to very soft subsurface soil and groundwater conditions, ground improvement is recommended. Construction of the CBC will require excavations extend below groundwater elevations, therefore dewatering and control of groundwater during construction should be anticipated. A permanent subsurface drainage system will also be required to control groundwater after construction. A discussion of ground improvement mitigation for a shallow foundation system is presented in Section 9.1.

9.1 Underpass Foundation Recommendations with Ground Improvement

Boreholes UP-1 and UP-2 were advanced at the general location of the proposed underpass CBC structure. RockSol considers a design groundwater elevation of 4,560 feet appropriate for this location. Borehole information from T-1 through T-3 was also used for providing geotechnical recommendations for the pedestrian underpass structure, if elected to attach the pedestrian underpass CBC structure to the G Road over North Leach Creek structure.

Based on conditions encountered in RockSol Boreholes UP-1, UP-2, and T-1 through T-3 ground improvement is recommended to achieve a service bearing resistance greater than 750 psf for a 4-sided CBC system.

At a minimum, RockSol recommends ground improvement consisting of overexcavation of subgrade soils to a minimum depth of 2 feet below the bottom of the CBC bottom slab and replacement with at least 2-feet of a crushed aggregate material meeting CDOT No. 57 Concrete Aggregate which is fully wrapped with a CDOT approved Class 1 stabilization/separator geotextile placed at 6-inch intervals. The crushed aggregate and geotextile shall extend horizontally beyond the limits of the CBC a minimum of 5 feet in each direction (north/south and east/west). Placement of the aggregate material should be in horizonal lifts with a maximum lift thickness of 6 inches. Compaction of each lift with vibratory methods using lightweight equipment is recommended. RockSol recommends placement of at least 6-inches of CDOT Class 1 Structural Fill between the top of the geotextile wrapped granular material and the bottom of the foundation.

With two feet (vertically) of aggregate materials, RockSol considers a service bearing resistance of 1.0 ksf appropriate. If greater service bearing resistance is required, additional thickness of replaced subgrade soil is required. Bearing resistances, based on replacement thicknesses of aggregate is presented in Table 9.1.

Table 9.1 - Bearing Resistances for Shallow Foundations After Ground Improvement

Overexcavation And Replacement Thickness (No. 57 Material)	Strength Limit State (LRFD)		Service Limit State (LRFD)
	Ultimate (Nominal) Resistance (ksf)	**Factored Resistance (ksf)**	**Service Bearing Resistance (LRFD) (ksf)**
2 feet	4.6	2.1	1.0
3 feet	5.9	2.6	1.5
4 feet	7.7	3.4	2.0

A resistance factor of 0.45 is used to determine the factored bearing resistance for LRFD strength limit state evaluation. Service limit state, service bearing resistance is estimated to correspond to a total settlement of less than 1-inch. RockSol assumes a minimum foundation width of 6 feet for the CBC.

A representative of the geotechnical engineer should observe all foundation excavations prior to placement of the geotextile and aggregate material.

10.0 PEDESTRIAN BRIDGE OVER LEACH CREEK FOUNDATION RECOMMENDATIONS

The sedimentary bedrock encountered in the RockSol boreholes is considered suitable bearing material for supporting structures such as the proposed pedestrian bridge at the confluence of Leach Creek and North Leach Creek, approximately 1,000 feet south of the corner of 24 Road and G Road. Drilled shafts (caisson) and driven steel H-piles are feasible foundation systems for the proposed pedestrian bridge structure. Geotechnical design parameters for the deep foundation are presented in Sections 10.1 and 10.2. Shallow foundations with ground improvement may also be feasible due to the lighter loads encountered in a pedestrian bridge.

10.1 Drilled Shaft Foundation System

Drilled shafts will provide support by embedment into sedimentary bedrock. Based on the subsurface conditions encountered, it is anticipated that very hard claystone/shale bedrock will be encountered at an approximate elevation 4,516 feet.

Based on our evaluation, recommended nominal (unfactored) base resistance and nominal (unfactored) side resistance values for the bedrock material are presented in Table 10.1 for use with Load and Resistance Factor Design (LRFD) methods.

Table 10.1: Base and Side Resistance Values for Drilled Shafts in Bedrock

Pedestrian Bridge Over Leach Creek	Estimated Bedrock Elevation at Borehole (feet)	Ultimate (Nominal) Resistance (LRFD)		Service Resistance (LRFD)	
		Base (ksf)	**Side (ksf)**	**Bearing (ksf)**	**Side (ksf)**
North Caisson	4,516 (LC-1)	138	11.3	47	3.8
South Caisson	4,516 (LC-2)				

The side resistance is applicable to the portion of the shaft embedded in competent bedrock. When evaluating the side resistance of the drilled shaft, the lower 1.0-diameter length above the shaft tip should be ignored. Side resistance in the soil zone above competent bedrock should be neglected when calculating axial resistance. For LRFD strength limit state evaluation, a resistance factor of 0.55 is recommended for base/ tip resistance and a resistance factor of 0.60 is recommended for side resistance evaluation for redundant single shafts. Per AASHTO LRFD

(Section 10.5.5.2.4) the resistance factors for base/tip and side resistance should be reduced by 20 percent for non-redundant single shafts.

For axial bearing, a minimum shaft embedment into bedrock of 5 feet is recommended.

Drilled shaft diameters shall be sufficient to satisfy axial, bending, and lateral load resistance requirements. In addition, the shaft diameters shall be sufficient to allow for use of casing, if required, and placement of reinforcement with adequate concrete cover.

Additional design and construction considerations for drilled shafts are presented below.

(f) The construction of the drilled shafts should follow the guidelines specified in the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 503, 2019."

(g) During construction of drilled shafts, casing or slurry methods may be required to support the excavation where holes are unstable due to soil and groundwater conditions. Groundwater was encountered in Boreholes LC-1 and LC-2 at an approximate depth 11.5 and 14 feet (approximate elevation of 4,549 and 4,546 feet), respectively, below the existing ground surface during drilling operations.

(h) Prior to the placement of the concrete, the drilled shaft excavation, including the bottom, should be cleaned of all loose material. For wet conditions (more than two inches of water), concrete placement by "tremie" methods should be used.

(i) Lateral load capacity of the drilled shafts should be evaluated. Geotechnical parameters for evaluation of lateral load capacity are provided in Table 10.2.

(j) Drilled shafts should be constructed with spacing at least four shaft diameters center to center. For closely spaced drilled shafts, the axial and lateral capacities should be appropriately reduced. Group action of drilled shafts should be analyzed on an individual basis to assess the appropriate reduction.

10.2 Driven Pile Foundation System

Alternatively, the proposed pedestrian bridge over Leach Creek may be supported on driven steel H-piles (Grade 50 steel). RockSol recommends the piles be driven to practical refusal in the bedrock. If significant penetration into bedrock (greater than 5 feet) is necessary for lateral resistance requirements, pre-drilling may be required.

For the LRFD method, a nominal (ultimate) geotechnical capacity of 36 ksi, based on the cross-section area of the pile, can be used for Grade 50 steel.

During construction, pile driving shall be monitored per CDOT requirements per Section 502 of the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), 2019". Monitoring shall be conducted using a Pile Driving Analyzer (PDA) to determine the condition of the pile, the efficiency of the hammer and the static bearing capacity of the pile, and to establish the pile driving criteria. A resistance factor of 0.65 is recommended for LRFD strength limit state design for axial compression provided PDA testing is performed.

Additional design and construction considerations for driven piles are presented below.

(g) Steel piling, pile driving equipment, and installation of the driven steel H-piles should follow the guidelines specified in "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 502, 2019".

(h) Lateral load parameters presented in Table 10.2 may be used for lateral load analysis. Battered piles may be used to resist the lateral loads. The battered piles inclination should be within one (1) horizontal to four (4) vertical.

(i) RockSol anticipates that 3 to 5 feet of pile penetration into bedrock will be required to achieve capacity. The actual length of the piles should be determined during installation.

(j) Center to center pile spacing should not be less than 30 inches or 2.5 pile diameters. For evaluation of horizontal pile foundation movement, the effects of group interaction shall be evaluated in accordance with AASHTO LRFD Bridge Design Specifications, Section 10.7.2.4.

(k) Pile tips should be protected against damage using driving shoes during penetration into the sedimentary bedrock.

(l) Potential damage to adjacent properties or structures during pile installation due to noise and vibrations should be considered and evaluated, if necessary.

Lateral Resistance Parameters (Drilled Shaft and Driven Pile Foundations)

Recommended preliminary lateral resistance parameters for drilled shafts and driven piles constructed are presented in Table 10.2. The parameters listed are for use with LPILE® or equivalent software.

Table 10.2: Drilled Shaft and Driven Pile Lateral Resistance Parameters

Borehole Material	L-Pile Soil Type	Undrained Shear Strength (psf)	Angle of Internal Friction (degrees)	Subgrade Reaction Coefficient (pci)	Strain Factor ε_{50} (%)	Unit Weight (pcf)
CLAY, silty to sandy, above water table	Stiff clay w/o free water	500	0	500	0.015	125 (Total)
CLAY, silty to sandy, below water table	Stiff clay w/ free water	250	0	100	0.025	63 (Submerged)
SAND, with gravel, Below water table	Sand	0	34	60	--	63 (Submerged)
Claystone/Shale Bedrock	Stiff clay w/o free water	8,000	0	2,000	0.004	125 (Total)

Total unit weight indicated in the table above includes soil plus moisture content. Depths at which groundwater were encountered are indicated on the attached borehole logs.

10.3 Shallow Foundation Recommendations with Ground Improvement

Boreholes LC-1 and LC-2 were advanced at the approximate location of the abutments for the proposed pedestrian bridge structure. RockSol considers a design groundwater elevation of 4,549 feet appropriate for this location.

Based on conditions encountered in RockSol Boreholes LC-1 and LC-2, ground improvement is recommended to achieve a service bearing resistance greater than 750 psf for a shallow foundation system.

At a minimum, RockSol recommends ground improvement consisting of overexcavation of subgrade soils to a minimum depth of 2 feet below the bottom of the foundation bottom slab and replacement with at least 2-feet of a crushed aggregate material meeting CDOT No. 57 Concrete

Aggregate which is fully wrapped with a CDOT approved Class 1 stabilization/separator geotextile placed at 6-inch intervals. The crushed aggregate and geotextile shall extend horizontally beyond the limits of the CBC a minimum of 5 feet in each direction (north/south and east/west). Placement of the aggregate material should be in horizonal lifts with a maximum lift thickness of 6 inches. Compaction of each lift with vibratory methods using lightweight equipment is recommended. RockSol recommends placement of at least 6-inches of CDOT Class 1 Structural Fill between the top of the geotextile wrapped granular material and the bottom of the foundation.

With two feet (vertically) of aggregate materials, RockSol considers a service bearing resistance of 1.0 ksf appropriate. If greater service bearing resistance is required, additional thickness of replaced subgrade soil is required. Bearing resistances, based on replacement thicknesses of aggregate is presented in Table 10.3.

Table 10.3 - Bearing Resistances for Shallow Foundations After Ground Improvement

Overexcavation And Replacement Thickness (No. 57 Material)	**Strength Limit State (LRFD)**		**Service Limit State (LRFD)**
	Ultimate (Nominal) Resistance (ksf)	**Factored Resistance (ksf)**	**Service Bearing Resistance (LRFD) (ksf)**
2 feet	4.6	2.1	1.0
3 feet	5.9	2.6	1.5
4 feet	7.7	3.4	2.0

A resistance factor of 0.45 is used to determine the factored bearing resistance for LRFD strength limit state evaluation. Service limit state, service bearing resistance is estimated to correspond to a total settlement of less than 1-inch. RockSol assumes a minimum foundation width of 6 feet for the foundation system.

A representative of the geotechnical engineer should observe all foundation excavations prior to placement of the geotextile and aggregate material.

11.0 PAVEMENT DESIGN RECOMMENDATIONS

New pavement is planned for the proposed 24 Road and G Road traffic circle (roundabout) and sections of 24 Road and G Road. Pavement thickness evaluation for development of flexible and rigid pavement design recommendations within the City of Grand Junction right of way was performed in accordance with *Chapter 29.32 – Pavements and Truck Routes* (April 21, 2004) in the City of Grand Junction Municipal Code, *AASHTO Guide for the Design of Pavements* (1993 with the 1998 update for rigid pavement) and the *Guideline for the Design and Use of Asphalt Pavements for Colorado Roadways* (January, 2006), published by the Colorado Asphalt Pavement Association. Correlation of subgrade soil R-Value to Resilient Modulus for this report was performed using the latest correlation used by the Colorado Asphalt Pavement Association. 24 Road is classified as principal arterial and G Road is classified as minor arterial by the City.

11.1 Traffic Loading

Traffic loading was estimated for a 30-year design life in accordance with the City of Grand Junction Municipal Code (Chapter 29.32). The largest of the two vehicle counts for both G road and 24 Road approaching the intersection were taken from the 2035 projections of average daily traffic provided by Fehr and Peers as the midpoint traffic load given the design life. They were then used separately to calculate the equivalent single axle loading (ESALs) on the roadway sections and added together to estimate loading on the roundabout pavement. The 2 percent heavy vehicle ratio was considered for combination trucks, and Rocksol assumed a conservative estimate of 13 percent single axle trucks in the total traffic count.

Traffic data and projections are available in Appendices C through E.

11.2 Pavement Subgrade Characterization

Subgrade bulk samples within the upper four feet of existing roadway grades were obtained at each borehole location and were tested for AASHTO soil classification. The subgrade soils tested classified as A-1-a, A-1-b, A-2-4, A-4, and A-6 AASHTO soil types (See Sections 5.2 and 5.3).

Based on R-Value testing, an R-Value of 20 with a corresponding subgrade resilient modulus value of 4,940 psi was used by RockSol as the design R-value for evaluation of new pavement constructed on the existing site soils.

To provide an appropriate structural transitional material for flexible pavement (HMA), RockSol recommends a subbase soil layer of CDOT Class 1 aggregate base course (ABC) be included as part of the pavement design section in addition to the CDOT Class 6 ABC directly underlying the pavement. A structural coefficient of 0.12 was used for Class 6 ABC, 0.11 for Class 1 ABC and 0.44 for HMA. The Class 1 ABC must have an R-Value of at least 70 and the Class 6 ABC must have an R-Value of at least 78.

For pavement design, RockSol is providing individual pavement thickness recommendations for the roundabout and the adjacent connecting roadways.

11.3 Pavement Section Recommendations

A summary of the recommended pavement section thicknesses for flexible pavement constructed over CDOT Class 6 ABC placed on existing soils and on CDOT Class 1 ABC subbase soils, and rigid pavement placed on CDOT Class 6 ABC over existing soils in the roundabout section is presented in Table 11.3a and the pavement design output sheets are included in Appendix C.

Table 11.3a – Pavement Section Thickness Recommendations (24 Road and G Road Roundabout) (30 Year Design Life)

<table>
<tr><th>Subgrade/Subbase</th><th>Structural Layering</th><th>Material Type</th><th>Thickness</th></tr>
<tr><td rowspan="2">Existing Soils
(R-Value = 20)</td><td rowspan="2">HMA
Over CDOT Class 6 ABC</td><td>HMA</td><td>10.25 inches</td></tr>
<tr><td>ABC</td><td>8 inches</td></tr>
<tr><td rowspan="2">Existing Soils
(R-Value = 20)</td><td rowspan="2">PCCP
Over CDOT Class 6 ABC</td><td>PCCP</td><td>9 inches</td></tr>
<tr><td>CDOT Class 6 ABC</td><td>8 inches</td></tr>
<tr><td rowspan="3">CDOT Class 1 ABC Over
Existing Soils</td><td rowspan="3">HMA Over
CDOT Class 6 ABC
Over CDOT Class 1 ABC</td><td>HMA</td><td>6 inches</td></tr>
<tr><td>CDOT Class 6 ABC</td><td>8 inches</td></tr>
<tr><td>CDOT Class 1 ABC</td><td>16 inches</td></tr>
</table>

HMA = Hot Mix Asphalt; ABC = Aggregate Base Course; PCCP = Portland Cement Concrete Pavement

A summary of the recommended pavement section thicknesses for flexible pavement constructed over CDOT Class 6 ABC placed on existing soils and on CDOT Class 1 ABC subbase soils, and rigid pavement placed on CDOT Class 6 ABC over existing soils at 24 Road is presented in Table 11.3b and the pavement design output sheets are included in Appendix D.

**Table 11.3b – Pavement Section Thickness Recommendations (24 Road)
(30 Year Design Life)**

Subgrade/Subbase	Structural Layering	Material Type	Thickness
Existing Soils (R-Value = 20)	HMA Over CDOT Class 6 ABC	HMA	9.5 inches
		ABC	8 inches
Existing Soils (R-Value = 20)	PCCP Over CDOT Class 6 ABC	PCCP	8.5 inches
		CDOT Class 6 ABC	8 inches
CDOT Class 1 ABC Over Existing Soils	HMA Over CDOT Class 6 ABC Over CDOT Class 1 ABC	HMA	6 inches
		CDOT Class 6 ABC	8 inches
		CDOT Class 1 ABC	14 inches

HMA = Hot Mix Asphalt; ABC = Aggregate Base Course; PCCP = Portland Cement Concrete Pavement

A summary of the recommended pavement section thicknesses for flexible pavement constructed over CDOT Class 6 ABC placed on existing soils and on CDOT Class 1 ABC subbase soils, and rigid pavement placed on CDOT Class 6 ABC over existing soils at G Road is presented in Table 10.3c and the pavement design output sheets are included in Appendix E.

**Table 11.3c – Pavement Section Thickness Recommendations (G Road)
(30 Year Design Life)**

Subgrade/Subbase	Structural Layering	Material Type	Thickness
Existing Soils (R-Value = 20)	HMA Over CDOT Class 6 ABC	HMA	8.5 inches
		ABC	8 inches
Existing Soils (R-Value = 20)	PCCP Over CDOT Class 6 ABC	PCCP	7.5 inches
		CDOT Class 6 ABC	8 inches
CDOT Class 1 ABC Over Existing Soils	HMA Over CDOT Class 6 ABC Over CDOT Class 1 ABC	HMA	6 inches
		CDOT Class 6 ABC	8 inches
		CDOT Class 1 ABC	10 inches

HMA = Hot Mix Asphalt; ABC = Aggregate Base Course; PCCP = Portland Cement Concrete Pavement

HMA pavement shall consist of CDOT-approved mix designs. The full depth of new HMA should consist of S(100) PG 64-22 or SX(100) PG 64-22 materials to resist rutting damage. ABC should consist of material meeting CDOT Class 5 or 6 Aggregate Base Course and subbase should consist of material meeting CDOT Class 1 Aggregate Base Course per CDOT 703.03. Concrete pavement shall have transverse joint spacing of 12 feet with a panel width of 12 feet and use 1.25-inch diameter (#9) dowels to resist faulting. Concrete mix designs shall consist of CDOT-approved mixes for pavements.

11.4 Subgrade Preparation (Prior to Pavement Construction)

Prior to construction of new pavements on subgrade soils, the underlying subgrade should be properly prepared by removal of all organic matter (topsoil), debris, loose material, and any deleterious material identified by the Project Engineer followed by scarification, moisture conditioning and recompaction. The minimum depth of scarification, moisture conditioning and re-compaction in all cases shall be 6 inches. Cobbles greater than 6 inches in diameter, if encountered, should be removed from the scarification zone.

Prior to pavement section construction, subgrade proof rolling with pneumatic tire equipment shall be performed using a minimum axle load of 18 kips per axle after specified subgrade compaction has been obtained. Areas found to be weak and those areas which exhibit soft spots, non-uniform deflection or excessive deflection as determined by the project engineer shall be ripped, scarified, wetted or dried if necessary, and re-compacted to the requirements for density and moisture. Complete coverage of the proof roller will be required. The use of flyash to assist with subgrade stabilization is acceptable if the contractor proposes to use it.

All pavement subgrade preparation, including final proof-rolling, pavement materials, and pavement construction shall conform to the *Guideline for the Design and Use of Asphalt Pavements for Colorado Roadways* (January 2006). The subgrade should be compacted to a uniform density of 95 percent of the maximum density determined by the Standard or Modified Proctor density (ASTM D698 or ASTM D1557). See Table 11.3 for the required compaction standard by soil type.

Table 11.3 –Roadway Subgrade Compaction Specifications

AASHTO Classification	Minimum Relative Compaction (Percentage of MDD), %	Moisture Content (Deviation from OMC)
A-1-a, A-1-b, A-2-4, A-4	95% of ASTM D1557	-3 to +3
A-6, A-7-6	95% of ASTM D698	-2 to +2

MDD = Maximum Dry Density; OMC = Optimum Moisture Content

Based on the results of our field and laboratory tests, A-1-a, A-1-b, A-2-4, A-4 and A-6 soils are anticipated to be encountered at existing pavement subgrade elevations within the project limits.

12.0 EARTHWORK

<u>North Leach Creek Backfill Recommendations</u>

As part of the proposed roundabout at the intersection of G Road and 24 Road, North Leach Creek is proposed to be relocated east of its present alignment. The approximate layout has been provided by the City of Grand Junction (See Figure 8). The new G Road and 24 Road intersection will be constructed over backfill material placed within the old alignment of North Leach Creek once it is relocated. This backfill zone of North Leach Creek is estimated to be approximately 350 linear feet along the eastern side of 24 Road. RockSol understands the existing utilities will be removed and/or abandoned following removal of the existing 24 Road bridge over North Leach Creek.

Due to the presence of soft to very soft subsurface soil and groundwater conditions, ground improvement is recommended for the proposed backfilling operations to reduce settlement potential within the new roadway improvements. Control of groundwater during backfill placement should be anticipated. Based on data collected from Boreholes T-1 through T-3, RockSol considers a design groundwater elevation of 4,557 feet appropriate for this location.

Prior to placing backfill, RockSol recommends ground improvement consisting of overexcavating North Leach Creek soil/sediment deposits and vegetation (creek muck) to a minimum depth of 12-inches and subsequent placement with at least 3-feet of a crushed aggregate material meeting CDOT No. 57 Concrete Aggregate, which is fully wrapped with a CDOT approved Class 1 stabilization geotextile placed at 12-inch intervals. A total of 3 stabilization/separator geotextile layers are recommended. Before placing the first layer of stabilization geotextile and No. 57 rock, a layer of pit run material consisting of sands, gravel, and rock/cobble may be used following the muck removal to provide a working platform layer. Consultation with the geotextile manufacture/contractor to ensure proper soil/rock/geotextile interaction is recommended.

The crushed aggregate (No. 57 rock) and geotextile shall extend a minimum of 12-inches horizontally into the creek bank slope. The ends of each layer of geotextile must also extend upward at least 12-inches along the interface of the aggregate fill and the creek bank soil to prevent site soils from migrating into the fill aggregate. Placement of the aggregate material should be in horizonal lifts with a maximum lift thickness of 6 inches. Compaction of each lift using lightweight vibratory equipment is recommended. Each lift of aggregate backfill material should be compacted with a minimum of 3 complete passes of the vibratory compaction equipment.

Above the 3-foot stabilized zone, CDOT Class 2 Aggregate Base Course material is recommended as backfill up to the final pavement section subgrade elevation.

New Embankment

To accommodate widening of 24 Road and G Road, new embankment may be required along the roadway alignments. At some locations minor cuts may be required. Materials used to construct embankments, roadway side slopes, structure backfill, and aggregate base course materials should meet the material and moisture density control requirements specified in Article IV of the Mesa County Standard Specifications for Road and Bridge Construction and City of Grand Junction Transportation Engineering Design Standards (current editions).

At a minimum, the ground surface underlying all embankment fills should be carefully prepared by removing all organic matter (topsoil), scarification to a minimum depth of 6 inches and recompacting to the requirements for maximum dry density and moisture content listed in Table 11.1 of this report prior to fill placement.

Where fill material is to be placed on existing slopes steeper than 4 (H):1 (V), benching must be performed to tie the new fill into the existing slope. Benching into the existing slopes shall allow sufficient bench width to accommodate placing and compaction equipment to operate in a horizontal orientation.

Broken concrete, broken asphalt, or other solid materials more than 6 inches in greatest dimension shall not be placed within embankment areas supporting the roadway shoulders and pavement structure. Claystone materials shall not be used for construction of new embankment. Imported fill material used for embankment constructed shall be compatible with designed side slopes. Material excavated from utility trenches may be used for backfilling provided it does not contain unsuitable material or particles larger than 3 inches. Unsuitable material includes, but is limited to, topsoil, vegetation, brush, sod, trash, and other deleterious substances.

13.0 SEISMICITY DISCUSSION

13.1 General

Boreholes LC-1, LC-2, T-1, T-2 and T-3 terminated at depths ranging from approximately 48 feet to 72 feet below existing grades at the G Road and North Leach Creek crossing and the proposed pedestrian bridge over Leach Creek location. Based on the subsurface conditions encountered, including blow counts and laboratory testing, it is our opinion that the subject structure sites meet criteria for Seismic Site Class E, as defined by AASHTO LRFD Table 3.10.3.1-1. Shear wave velocity testing was not performed by RockSol. Soil conditions necessary for Site Class F were not encountered in RockSol's boreholes.

For final design, RockSol recommends performing shear wave velocity testing or performing penetration tests to a depth of 100 feet if determination of Seismic Site Class D conditions is necessary. Seismic design parameters for Seismic Site Class E are discussed below.

13.2 Seismic Design Parameters

Seismic design parameters were obtained from the *2017 AASHTO Guide Specifications for LRFD Seismic Bridge Design*. Interpolated values for Peak Ground Acceleration Coefficient (PGA), Spectral Response Acceleration Parameter for Short Period (S_s), and Spectral Response Acceleration Parameter at 1-s Period (S_1) were obtained using Figures 3.10.2.1-1, 3.10.2.1-2 and 3.10.2.1-3 of the *2017 AASHTO Guide Specifications for LRFD Seismic Bridge Design* for the project site. The seismic acceleration coefficients obtained from the Design Maps are presented in Table 13.2.1.

Table 13.2.1 – Seismic Acceleration Coefficients

G Road and 24 Road Project (Latitude°/Longitude°)	Peak Ground Acceleration (PGA)	Spectral Acceleration Coefficient - S_s (Period 0.2 sec)	Spectral Acceleration Coefficient - S_1 (Period 1.0 sec)
(39° 06’ 22.73”/ -108° 36’ 29.45”)	0.08	0.16	0.045

The acceleration coefficients are then used to obtain Site Factors F_{pga}, F_a, and F_v based on the defined Site Class as shown in Tables 3.10.3.2-1, 3.10.3.2-2 and 3.10.3.2-3 of the *2017 AASHTO Guide Specifications for LRFD Seismic Bridge Design*. A summary of the Site Factor values obtained are shown in Table 13.2.2.

Table 13.2.2 – Seismic Site Factor Values

G Road and 24 Road Project (Latitude°/Longitude°)	F_{pga} (at zero-period on acceleration spectrum)	F_a (for short period range of acceleration spectrum)	F_v (for long period range of acceleration spectrum)
(39° 06’ 22.73”/ -108° 36’ 29.45”)	2.5	2.5	3.5

Values for S_1 and F_v are presented in Tables 13.2.1 and 13.2.2, shown above. The seismic design category was determined with the *2017 AASHTO Guide Specifications for LRFD Seismic Bridge Design* Table 3.10.6-1. Table 13.2.3 summarizes the Seismic Design Category determination and horizontal response spectral Acceleration Coefficients (S_{DS} *and* S_{D1}) obtained for the proposed structure. Seismic Performance Zone determination is based on the value of the horizontal response spectral Acceleration Coefficient, S_{D1}, as determined by *Eq. 3.10.4.2-6* and S_{DS}, as determined by *Eq. 3.10.4.2-3* of the *2017 AASHTO Guide Specifications for LRFD Seismic Bridge Design.*

Table 13.2.3 – Seismic Performance Zone

G Road and 24 Road Project (Latitude°/Longitude°)	Acceleration Coefficient (S_{D1})	Seismic Zone (1)	Acceleration Coefficient, S_{DS}
(39° 06’ 22.73”/-108° 36’ 29.45”)	0.157	2	0.4

Note 1: Seismic Zone 2 is assigned when $0.15 < S_{D1} \leq 0.30$.

14.0 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

Proper construction practices, in accordance with City of Grand Junction Transportation Engineering Design Standards and Mesa County Standard Specifications for Road and Bridge Construction (current editions), should be followed during site preparation, earthwork, excavations, roadway and bridge construction, and embankment and retaining wall construction for the suitable long-term performance of the proposed improvements. Excavation support should be provided to maintain onsite safety and the stability of excavations and slopes. Excavations shall be constructed in accordance with local, state and federal regulations including OSHA guidelines. The contractor must provide a competent person to determine compliance with OSHA excavation requirements. For preliminary planning, existing fill material and native soils may be considered as OSHA Type C soils.

Surface drainage patterns may be altered during construction and local landscape irrigation (if any) must be controlled to prevent excessive moisture infiltration into the subgrade soils during and after construction.

Environmentally contaminated material, if encountered, should be characterized and removed under the direction of the project environmental consultant. Design and construction plans should be reviewed, and onsite construction should be observed by the professional engineers.

15.0 LIMITATIONS

This geotechnical investigation was conducted in general accordance with the scope of work. RockSol's geotechnical practices are similar to those used in Colorado with similar soil conditions and based on our understanding of the proposed work. This report has been prepared for use by the City of Grand Junction for the project described in this report. The report is based on our exploratory boreholes and does not consider variations in the subsurface conditions that may exist between boreholes. Additional investigation is required to address such variation. If during construction activities, materials or water conditions appear to be different from those described herein, RockSol should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. RockSol is not responsible for liability associated with interpretation of subsurface data by others.

Borehole Location Plan Sheets

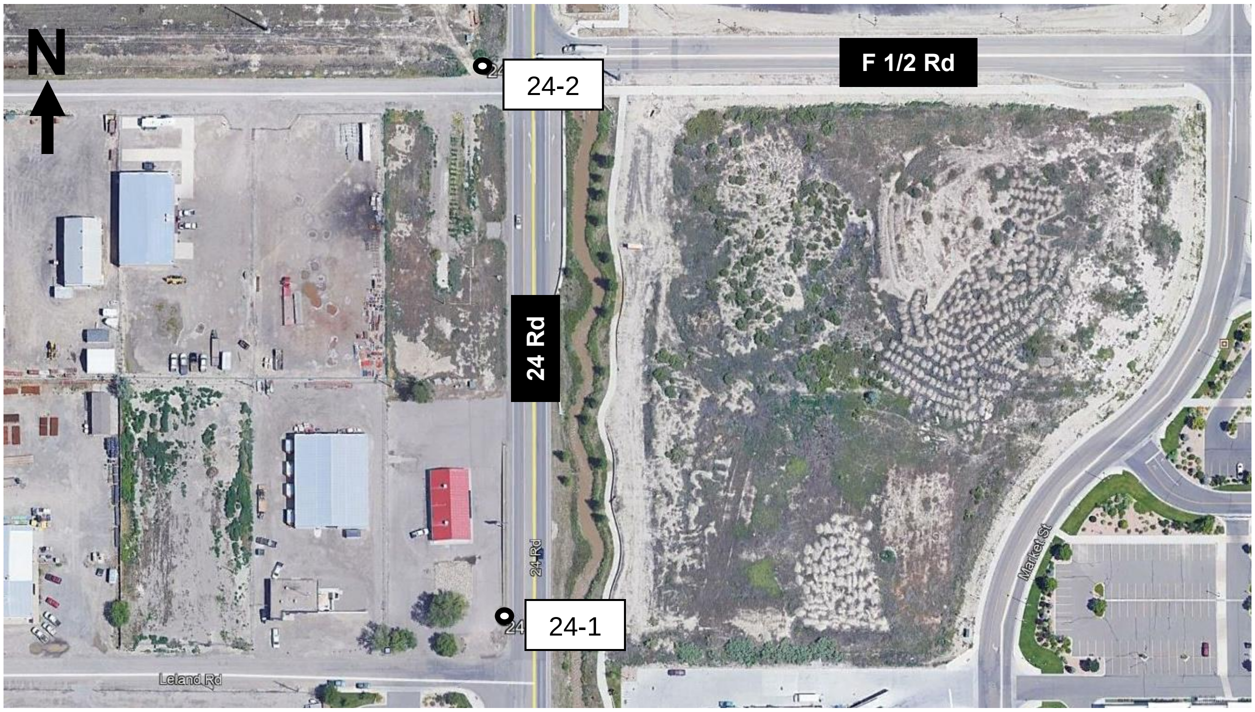


Figure 1 – Boreholes 24-1 and 24-2

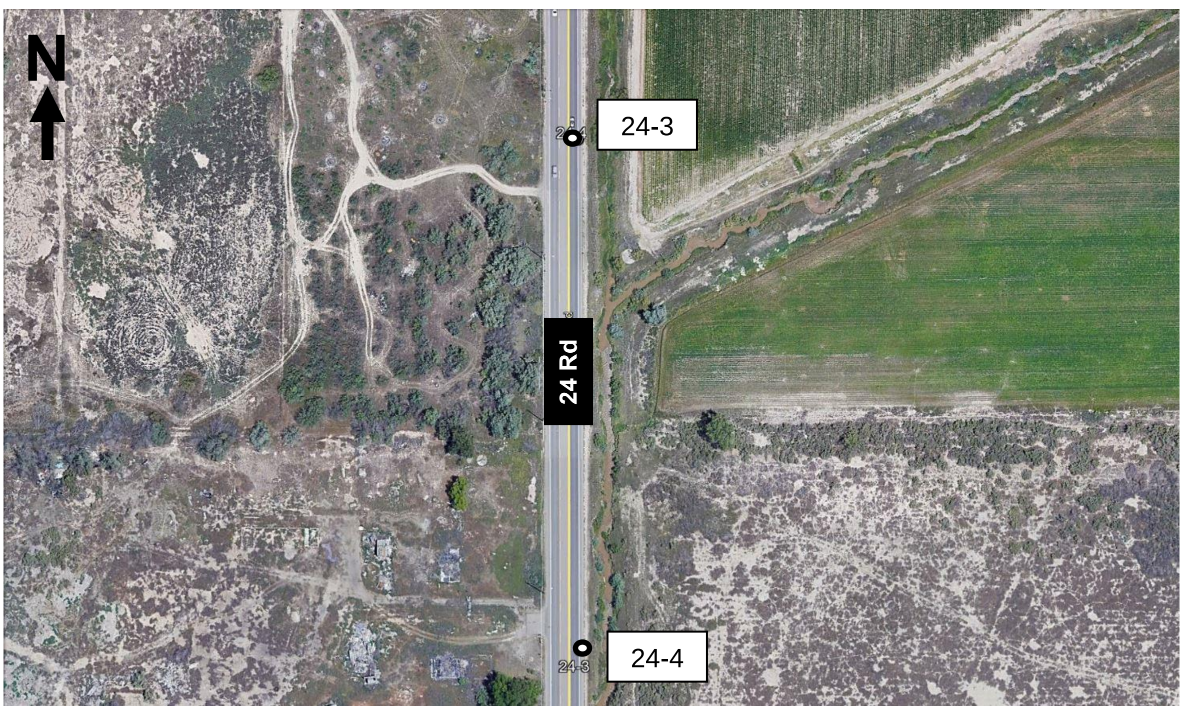


Figure 2 – Boreholes 24-3 and 24-4

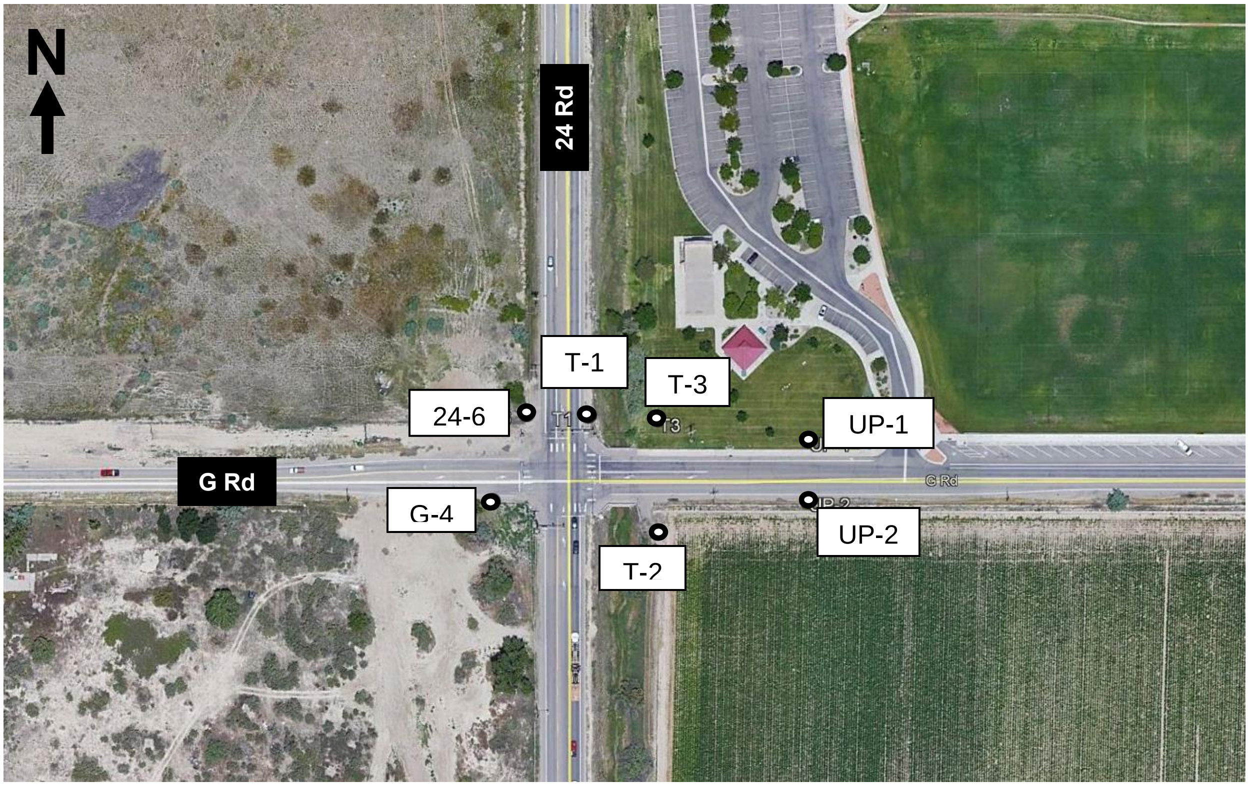


Figure 3 – Boreholes 24-6, G-4, T-1, T-2, T-3, UP-1, and UP-2

Figure 4 – Borehole 24-7

Figure 5 – Boreholes G-1 and G-2

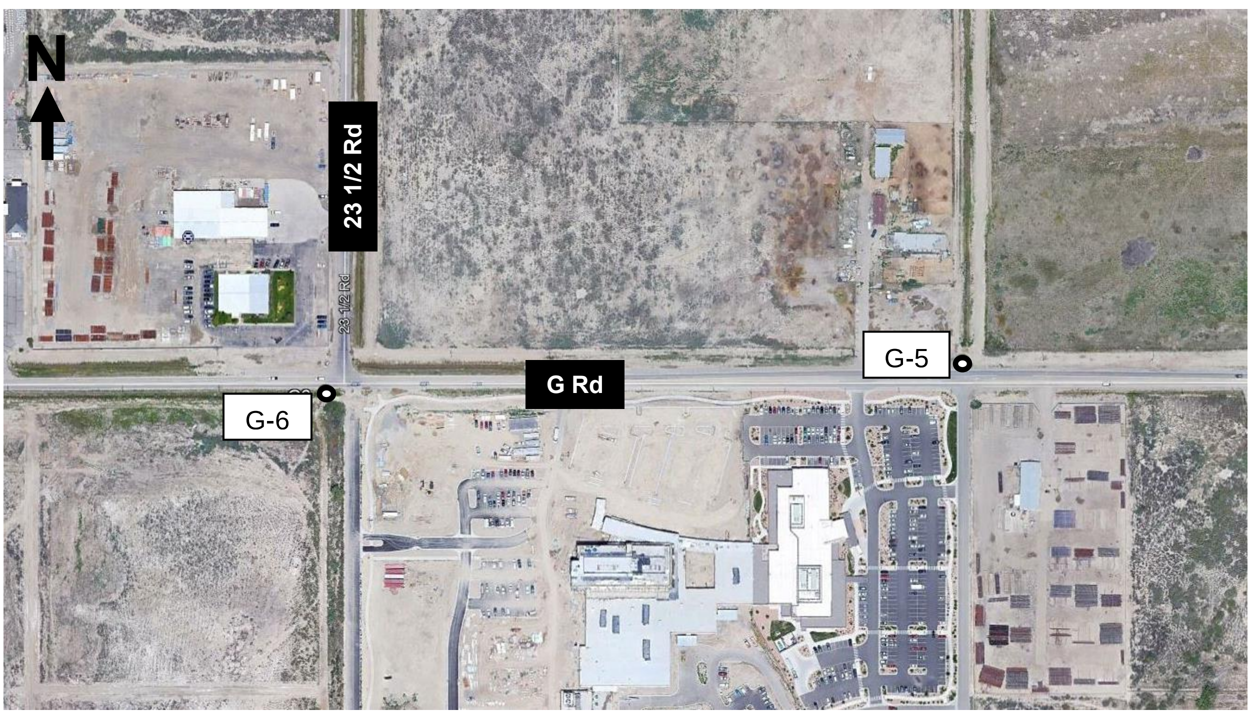


Figure 6 – Boreholes G-5 and G-6

Proposed Pedestrian Bridge Location over Leach Creek

Figure 7 - Leach Creek Pedestrian Bridge Borehole Location Plan

N

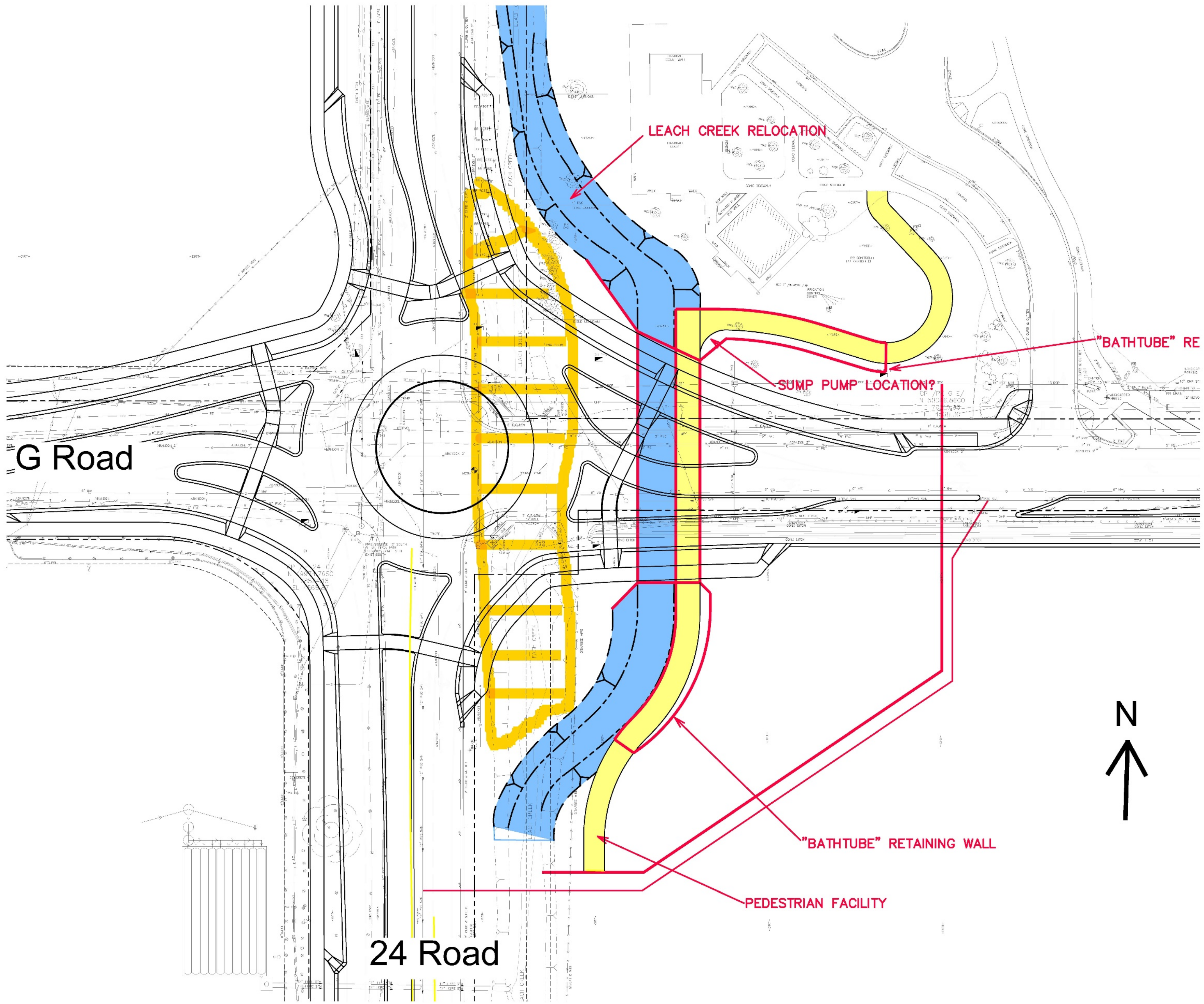
0 0.075 0.15 mi

Date: 7/8/2020

1 inch = 188 feet

City of Grand Junction Colorado Geographic Information System

Figure 8: North Leach Creek Realignment Conceptual Plan



APPENDIX A

LEGEND AND INDIVIDUAL BOREHOLE LOGS

LEGEND

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO

LITHOLOGY

- Asphalt Pavement
- Fill - Aggregate Base Course
- Fill - SAND
- Fill - SAND
- TOPSOIL
- Native - SAND
- Native - SAND, silty
- Native - SAND, gravelly
- Native - SAND, clayey
- Native - CLAY
- Native - CLAY, silty
- Native - CLAY, sandy
- Native - SILT
- Native - SILT, sandy
- Native - GRAVEL, silty
- Bedrock - CLAYSTONE

SAMPLE TYPE

- Bulk Sample (Auger Cuttings)
- GRAB SAMPLE FROM CUTTINGS
- MODIFIED CALIFORNIA SAMPLER 2.5" O.D. AND 2" I.D. WITH BRASS LINERS INCLUDED
- SPLIT SPOON SAMPLER 2" O.D. AND 1 3/8" I.D. NO LINERS

15/12 Indicates 15 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 12 inches.

50/11 Indicates 50 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 11 inches.

5,5,5 Indicates 5 blows, 5 blows, 5 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 18 inches.

▼ GROUND WATER LEVEL NOTED AT THE TIME OF DRILLING

BORING : 24-1

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4553.7 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78849.2 **EAST** 46796.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: SB 24 Rd, outside shoulder
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES ~2' W of white edge line
WATER DEPTH None Encountered on 6/9/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4553.7	0		Asphalt pavement, approximately 8" thick										
			(Fill) SAND, slightly silty and gravelly to with silt and gravel, slightly moist to moist, brown, medium dense to loose	BULK			0.43			NP	NP	NP	17.8
4552.7	1		**Approximate Bulk Depth 0.67-4** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 17.8 Sulfate= 0.43										
4551.7	2			MC	28/12			121.7	3.2	NP	NP	NP	11.8
4550.7	3												
4549.7	4			MC	7/12			106.2	20.1				
4548.7	5		Bottom of hole at 5.0 feet.										

BORING : 24-2

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4554.1 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78832.6 **EAST** 47363.1
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: SB 24 Rd, off shoulder
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES NW corner of F 1/2 Rd & 24 Rd
WATER DEPTH None Encountered on 6/9/20

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4554.1	0	(Aggregate Base Course) SAND, gravelly, approximately 12" thick **Approximate Bulk Depth 0-1** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 18.5	BULK						NP	NP	NP	18.5
4553.1	1	(Native) CLAY, with sand, silty, moist, brown, medium stiff **Approximate Bulk Depth 1-4** Liquid Limit= 30 Plastic Limit= 16 Plasticity Index= 14 Fines Content= 78.5 Sulfate= 0.32	BULK			0.32			30	16	14	78.5
4552.1	2		MC	6/12			105.9	14.5				85.9
4551.1	3	(Native) CLAY, with sand, moist, brownish gray, medium stiff, iron staining										
4550.1	4		MC	5/12	0.1		104.1	17.7				
4549.1	5	Bottom of hole at 5.0 feet.										

RockSol Consulting Group, Inc.

BORING : 24-3

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4559.0 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78895.7 **EAST** 48502.0
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: NB 24 Rd, outside shoulder
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES ~2" E of white edge line & ~1000' N of F 1/2 Rd
WATER DEPTH None Encountered on 6/9/20

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4559.0	0	Asphalt pavement, approximately 8" thick										
4558.0	1	(Aggregate Base Course) SAND, slightly silty to gravelly with CLAY, slightly moist to moist, brownish gray, medium dense to dense **Approximate Bulk Depth 0.67-2.5** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 16.0 Sulfate= 0.29	BULK			0.29			NP	NP	NP	16.0
4557.0	2		MC	32/12			129.1	7.5				34.2
		(Native) SAND, silty to clayey with sandy SILT in parts, moist, brownish gray, medium dense to dense **Approximate Bulk Depth 2.5-4** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 40.9 Sulfate= 0.08	BULK			0.08			NP	NP	NP	40.9
4556.0	3											
4555.0	4	(Native) SAND, trace silt and gravel, moist, brown, medium dense	MC	10/12			111.7	8.8				
4554.0	5	Bottom of hole at 5.0 feet.										

BORING : 24-4

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4562.0 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78886.0 **EAST** 49277.7
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: NB 24 Rd, outside shoulder
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES ~2" E of white edge line
WATER DEPTH 4' on 6/9/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	FINES CONTENT (%)
4562.0	0		Asphalt pavement, approximatley 8.5" thick										
			(Aggregate Base Course) SAND, gravelly	BULK			0.26			NP	NP	NP	15.1
4561.0	1		(Fill) SAND, slightly silty to gravelly, slightly moist to moist, brown, medium dense to dense **Approximate Bulk Depth 0.71-2** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 15.1 Sulfate= 0.26										
4560.0	2		(Native) SILT, sandy with clayey SAND in parts, slightly moist to moist, brownish gray, hard **Approximate Bulk Depth 2-4** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 60.7 Sulfate= 0.37	BULK MC	34/12	0.0	0.37	127.5	10.0	NP	NP	NP	60.7
4559.0	3												
4558.0	4		(Native) SAND, with gravel to gravelly, wet, brown, very loose	MC	3/12			102.9	21.6				
4557.0	5		Bottom of hole at 5.0 feet.										

BORING : 24-6

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4566.0 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78830.4 **EAST** 50076.0
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: NW corner of 24 Rd & G Rd
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES off shoulder, ~15' W & 50' N
WATER DEPTH None Encountered on 6/9/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4566.0	0		(Aggregate Base Course) SAND, gravelly, approximately 6" thick	BULK			0.72			26	17	9	68.8
			(Fill) SAND, silty to gravelly in parts, CLAY lenses in parts, slightly moist, brown, loose **Approximate Bulk Depth 0-4** Liquid Limit= 26 Plastic Limit= 17 Plasticity Index= 9 Fines Content= 68.6 Sulfate= 0.72										
4565.0	1												
4564.0	2			MC	7/12			111.2	8.3				22.6
4563.0	3												
4562.0	4		(Native) SAND, clayey to silty, moist, brown, loose	MC	9/12	-0.8		111.9	16.2				
4561.0	5		Bottom of hole at 5.0 feet.										

RockSol Consulting Group, Inc.

BORING : 24-7

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4571.8 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78851.2 **EAST** 51211.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: SB 24 Rd, in lane
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
WATER DEPTH None Encountered on 6/9/20
NOTES On inside white edge line

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4571.8	0	Asphalt pavement, approximately 15" thick										
4570.8	1											
		(Fill) SAND, gravelly with SILT lenses in parts, slightly moist to moist, brown, medium dense **Approximate Bulk Depth 1.25-3.5** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 14.1 Sulfate= 1.38	BULK			1.38			NP	NP	NP	14.1
4569.8	2		MC	18/12			120.3	13.1				66.4
4568.8	3											
		(Native) CLAY, sandy, moist, brown, medium stiff										
4567.8	4		MC	7/12	-0.7		111.8	18.0				
4566.8	5	Bottom of hole at 5.0 feet.										

RockSol Consulting Group, Inc.

BORING : G-1

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4574.8 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 81368.3 **EAST** 49988.8
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: EB G Rd
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
WATER DEPTH None Encountered on 6/9/20
NOTES Off shoulder

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	FINES CONTENT (%)
4574.8	0.0		(Aggregate Base Course) SAND, gravelly, approximately 18" thick **Approximate Grab Sample Depth 0-1.5** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 10.0	GB						NP	NP	NP	10.0
			(Native) SAND, silty, fine to coarse grained, slightly moist to moist, light brown to brown, medium dense to loose, calcareous **Approximate Bulk Depth 1.5-7** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 40.0 Sulfate= 0.76	BULK			0.76			NP	NP	NP	40.0
						0.4		112.0	6.3				
4572.3	2.5			MC	22/12								
								106.3	16.1				
				MC	6/12								
4569.8	5.0												
			Bottom of hole at 7.0 feet.										

RockSol Consulting Group, Inc.

BORING : G-2

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4571.2 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 80314.4 **EAST** 50018.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: WB G Rd, outside shoulder
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES ~3" N of white edge line
WATER DEPTH None Encountered on 6/9/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4571.2	0.0		Asphalt pavement, approxiamtely 3" thick										
			(Aggregate Base Course) SAND, gravelly, approximately 9" thick **Approximate Bulk Depth 0.25-1.5** Liquid Limit= 19 Plastic Limit= 16 Plasticity Index= 3 Fines Content= 23.3	BULK						19	16	3	23.3
			(Native) SAND, silty to slightly clayey in parts, moist, brown, medium dense to loose **Approximate Bulk Depth 2-7** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 68.2 Sulfate= 0.40	BULK			0.40			NP	NP	NP	68.2
4568.7	2.5			MC	11/12			104.9	12.0				60.6
				MC	6/12	-0.1		114.5	15.8				
4566.2	5.0												
			Bottom of hole at 7.0 feet.										

RockSol Consulting Group, Inc.

BORING : G-4

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4565.3 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78800.2 **EAST** 49978.8
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: EB G Rd, off shoulder
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES SW corner of G Rd & 24 Rd
WATER DEPTH 4.0 ft on 6/9/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4565.3	0		(Aggragate Base Course) SAND, gravelly, approximately 4" thick										
			(Fill) SAND, silty to gravelly, moist, medium dense										
4564.3	1												
			(Native) SAND, silty to slightly clayey in parts, moist, brown, loose, gilsinite dust control odor noted **Approximate Bulk Depth 1.5-4**	B BULK									
4563.3	2			MC	6/12	0.0		108.4	18.7				
4562.3	3												
4561.3	4		(Native) SAND, silty with sandy CLAY lenses in parts, wet, brownish gray, loose, minor iron staining	MC	3/12	-1.1		99.2	23.8				
4560.3	5		Bottom of hole at 5.0 feet.										

RockSol Consulting Group, Inc.

BORING : G-5

CLIENT City of Grand Junction		**PROJECT NAME** 24 Rd & G Rd Improvements	
PROJECT NUMBER 599.07		**PROJECT LOCATION** Grand Junction, CO	
DATE STARTED 6/9/20	**COMPLETED** 6/9/20	**GROUND ELEVATION** 4555.5 ft	**STATION NO.**
DRILLING CONTRACTOR McCracken Drilling		**NORTH** 77564.8	**EAST** 50040.8
DRILLING METHOD Solid Stem Auger	**HOLE SIZE** 4.0"	**BORING LOCATION:** WB G Rd, off shoulder	
LOGGED BY R. Lepro	**HAMMER TYPE** Automatic	**GROUND WATER LEVELS:**	
NOTES		**WATER DEPTH** None Encountered on 6/9/20	

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4555.5	0		(Fill) SAND, gravelly with silt and trace clay, with cobbles in parts, slightly moist to moist, brown and dark gray, medium dense to dense **Approximate Bulk Depth 0-4** Liquid Limit= 24 Plastic Limit= 18 Plasticity Index= 6 Fines Content= 11.9 Sulfate= 0.49	BULK			0.49			24	18	6	11.9
4554.5	1												
4553.5	2			MC	18/12			114.7	7.0	NP	NP	NP	35.7
4552.5	3												
4551.5	4			MC	31/12			124.6	5.6				
4550.5	5		Bottom of hole at 5.0 feet.										

RockSol Consulting Group, Inc.

BORING : G-6

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION 4548.7 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 76215.5 **EAST** 49980.8
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: EB G Rd, off shoulder
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 6/9/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4548.7	0		(Fill) SAND, silty with gravel and cobbles **Approximate Bulk Depth 0-4** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 50.0 Sulfate= 0.4	B BULK			0.40			NP	NP	NP	50.0
4547.7	1												
4546.7	2		(Native) CLAY, sandy with silt, moist, brown, very stiff, slightly calcareous	MC	17/12	0.7		113.9	12.6				
4545.7	3		(Native) SAND, silty, slightly clayey in parts, moist, brown, loose										
4544.7	4			MC	6/12			114.2	8.7				
4543.7	5		Bottom of hole at 5.0 feet.										

RockSol Consulting Group, Inc.

BORING : LC-1

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 7/24/20 COMPLETED 7/24/20
GROUND ELEVATION 4561.7 ft STATION NO.
DRILLING CONTRACTOR DA Smith
NORTH 78973.5 EAST 48927.3
DRILLING METHOD Hollow Stem Auger HOLE SIZE 8.0"
BORING LOCATION: North side of Leach Creek
LOGGED BY D. Hamer HAMMER TYPE Automatic
GROUND WATER LEVELS:
NOTES ~1,000 ft S of G Rd & ~100' E of 24 Rd
WATER DEPTH 11.5 ft on 7/24/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4561.7	0		(Native) CLAY, silty to sandy, moist to wet, brown to light brown, very soft	BULK			0.16			25	18	7	75.5
			Approximate Bulk Depth 0-5 Liquid Limit= 25 Plastic Limit= 18 Plasticity Index= 7 Fines Content= 75.5 Sulfate= 0.16	MC	3/12			107.1	19.9				82.0
4551.7	10			MC	1/12	-0.6		93.1	25.1	25	20	5	
				MC	1/12			97.8	27.9				91.8
4541.7	20			MC	1/12	-1.4		99.2	24.4	25	16	9	
				MC	2/12			100.9	26.4				99.7
4531.7	30			MC	6/12			102.9	23.1				
			(Native) SAND, with gravel, wet, light brown, loose	MC	1/12			101.0	23.8	NP	NP	NP	12.3
4521.7	40			SS	13/32/26				15.7	NP	NP	NP	4.7
			(Native) SAND, with gravel, wet, light brown, dense to very dense										
			(Bedrock) SHALE/CLAYSTONE, moist, dark gray, very hard	SS	50/2.5		0.45		10.4				80.6
				SS	50/2.5				10.1				
			Bottom of hole at 49.3 feet.										

BORING : LC-2

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 7/24/20 **COMPLETED** 7/24/20
GROUND ELEVATION 4560.2 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith
NORTH 78963.8 **EAST** 48846.9
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: South side of Leach Creek
LOGGED BY D. Hamer **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES ~1,100' S of G Rd & ~100' E of 24 Rd
WATER DEPTH 14.0 ft on 7/24/20

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4560.2	0	(Native) CLAY, sandy to silty, moist to wet, brown, very soft										
			MC	3/12		1.32	105.5	20.1				93.1
			MC	2/12	-0.5		107.0	21.5	24	18	6	
4550.2	10		MC	1/12		0.12	98.9	23.7				
			MC	1/12	-0.3		106.0	22.4	20	19	1	
4540.2	20											
			MC	1/12			72.7	18.3				
4530.2	30	(Native) SAND, with cobbles, dense										
			SS	36/14/10				16.2				28.9
4520.2	40											
		(Bedrock) SHALE/CLAYSTONE, moist, dark gray, very hard	SS	52/1.5				23.5				11.5
			SS	50/2				7.5				76.2
		Bottom of hole at 49.2 feet.										

BORING : T-1

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/10/20 **COMPLETED** 6/10/20
GROUND ELEVATION 4567.4 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78901.3 **EAST** 50090.1
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: NE corner of 24 Rd & G Rd
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES Proposed bridge location
WATER DEPTH 9.0 ft on 6/10/20

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4567.4	0	(Fill) SAND, clayey to silty, gravel in parts, slightly moist, brown	BULK			0.40			NP	NP	NP	43.6
		(Native) CLAY, sandy, moist, brown, medium stiff, slightly calcareous	MC	6/12	0.4		110.7	14.2				
		(Native) CLAY, sandy to silty with SAND lenses in parts, wet, brown with gray to brown, soft										
4557.4	10		MC	2/12	-0.3		98.2	26.8				
		Approximate Bulk Depth 0-4 Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 43.6 Sulfate= 0.4	MC	2/12			150.8	24.9				77.1
4547.4	20											
		(Native) CLAY, sandy to silty with SAND lenses in parts, wet, gray brown, medium stiff to stiff	MC	6/12		0.13	95.4	25.9				
4537.4	30											
			MC	11/12			105.6	23.4				85.1
		(Native) GRAVEL, sandy with cobbles, wet, brown, dense										
4527.4	40											
		(Native) CLAY, sandy, (weathered CLAYSTONE), iron staining	SS	6/7/7				22.7				75.9
		(Bedrock) CLAYSTONE, sandy, moist, very hard	SS	50/6								
		Bottom of hole at 48.0 feet.										

BORING : T-2

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/12/20 **COMPLETED** 6/12/20
GROUND ELEVATION 4565.7 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78968.8 **EAST** 49964.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: SE corner of 24 Rd & G Rd
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES Within private property access/roadway entrance
▼ **WATER DEPTH** 8.0 ft on 6/12/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4565.7	0		(Native) CLAY, with silt and sand, SAND lenses in parts, very moist to wet, brown, very soft										
				SS	1/1/2				23.2	21	18	3	87.4
		▼											
4555.7	10			SS	0/1/1		0.08		27.1				
				MC	2/12	-1.0		94.7	26.7				
4545.7	20		(Native) CLAY, with silt, wet, brown, medium stiff	MC	5/12			95.3	27.9				95.9
4535.7	30			MC	8/12			98.4	23.5				
4525.7	40		(Native) GRAVEL, sandy to silty with cobbles, wet, brown, dense to very dense	SS	50/11				6.8	NP	NP	NP	10.3
			(Native) CLAY, weathered SHALE/CLAYSTONE, moist to very moist, brownish gray, hard										
4515.7	50												
			(Bedrock) SHALE/CLAYSTONE, moist, dark gray, very hard										
4505.7	60			SS	50/1		0.33		13.5				51.7
4495.7	70			SS	50/1								
			Bottom of hole at 70.1 feet.										

BORING : T-3

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/11/20 **COMPLETED** 6/11/20
GROUND ELEVATION 4566.5 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 78970.1 **EAST** 50072.3
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.0"
BORING LOCATION: NE corner, of 24 Rd & G Rd
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES ~20' E of canal & ~25' W of G Rd, in park
▼ **WATER DEPTH** 8.0 ft on 6/11/02

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4566.5	0	(Native) CLAY, silty, moist, brown with gray, soft, plant/grass roots encountered										
			MC	4/12	-0.7		97.1	25.2				
		(Native) CLAY, silty, wet, brown to brown with some black, soft	MC	2/12	-2.3		95.3	29.1				
4556.5	10											
			MC	3/12	-2.4		100.1	25.2				
4546.5	20		MC	4/12			91.6	28.1				98.3
		(Native) CLAY, with silt and sand, silty SAND lenses in parts, wet, brown, medium stiff										
4536.5	30		MC	5/12			93.5	26.1				
		(Native) GRAVEL, sandy with cobbles, wet, brown, very dense										
4526.5	40		SS	50/11				5.3	NP	NP	NP	7.3
4516.5	50											
		(Bedrock) SHALE/CLAYSTONE, moist, dark gray, very hard	BULK			0.24			27	15	12	55.4
4506.5	60											
			MC	50/1				2.3				
4496.5	70											
		Bottom of hole at 72.1 feet.	MC	50/1				12.1				

ATTERBERG LIMITS: LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX

BORING : UP-1

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/10/20 **COMPLETED** 6/10/20
GROUND ELEVATION 4567.0 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 79135.0 **EAST** 50063.1
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: Canyon View Park, NE corner of 24 Rd & G Rd
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES Proposed underpass, ~200' E of 24 Rd & ~50' N of G Rd
WATER DEPTH 7.0 ft on 6/10/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4567.0	0		(Topsoil) Grass landscape, approximately 6" thick										
			(Fill) SAND, silty to clayey with gravel, slightly moist to moist, brown										
			(Native) CLAY, silty, very moist, brown, soft										
4562.0	5			MC	4/12			98.0	25.3				98.9
			(Native) SILT, clayey, wet, brown, soft										
4557.0	10			MC	2/12		0.45	102.5	24.1				
4552.0	15			MC	2/12	-0.2		109.4	23.2				
			(Native) CLAY, silty, wet, brown, soft to stiff										
4547.0	20			MC	4/12	-3.9		97.5	27.8				
4542.0	25		(Native) CLAY, silty with SAND lenses, wet, brown, stiff										
4537.0	30			MC	8/12			108.2	21.1				
			Bottom of hole at 30.0 feet.										

BORING : UP-2

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/10/20 **COMPLETED** 6/10/20
EXISTING ELEVATION 4566.2 ft **PROPOSED ELEVATION** ft
DRILLING CONTRACTOR McCracken Drilling
NORTH 79120.2 **EAST** 49984.1
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: EB G Rd
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS: 1ST DEPTH 9.0 ft on 6/10/20
NOTES
2ND DEPTH 6.0 ft on 6/15/20

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
4566	0		(Topsoil) SAND, clayey, approximately 3" thick	BULK			0.40			26	16	10	75.4
			(Native) SAND, silty to slightly clayey in parts, moist, brown, loose										
				MC	6/12			98.9	9.6				20.0
			(Native) CLAY, silty with silty SAND lenses in parts, very moist to wet, brown, very soft										
4561	5			MC	1/12		0.36	96.2	23.2				80.2
			Approximate Bulk Depth 0-4 Liquid Limit= 26 Plastic Limit= 16 Plasticity Index= 10 Fines Content= 75.4 Sulfate= 0.4										
4556	10			MC	1/12	-3.3		100.1	23.0				
			(Native) SAND, silty with sandy CLAY in parts, wet, brown, very soft										
4551	15			MC	1/12	-0.1		100.5	26.5				
			(Native) CLAY, silty, wet, brown to brownish gray, soft to medium stiff										
4546	20			MC	3/12	-0.5		99.8	26.6				
4541	25			MC	5/12			98.6	27.6				
			Bottom of hole at 25.0 feet.										

APPENDIX B

SUMMARY OF LABORATORY TEST RESULTS

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NUMBER 599.07

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT LOCATION Grand Junction, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
24-1	0.67-4	NP	NP	NP		18	GM	A-1-b (0)				0.43		7.9				
24-1	2	NP	NP	NP		12		A-2-4 (0)	3.2	121.7								
24-1	4								20.1	106.2								
24-2	0-1	NP	NP	NP		18	GM	A-1-b (0)										
24-2	1-4	30	16	14		79	CL	A-6 (9)				0.32	480 @ 19.40%	7.9	0.0327			
24-2	2					86			14.5	105.9								
24-2	4				0.1				17.7	104.1								
24-3	0.67-2.5	NP	NP	NP		16	SM	A-1-b (0)				0.29	1400 @ 13.80%	7.9	0.0200			
24-3	2					34			7.5	129.1								
24-3	2.5-4	NP	NP	NP		41	SM	A-4 (0)				0.08	790 @ 16.3%	8.1	0.0300			
24-3	4								8.8	111.7								
24-4	0.71-2	NP	NP	NP		15	GM	A-1-b (0)				0.26		7.9				
24-4	2				0.0				10.0	127.5								
24-4	2.1-4	NP	NP	NP		61	ML	A-4 (0)				0.37	670 @ 16.30%	8.0	0.0300			
24-4	4								21.6	102.9								
24-6	0-4	26	17	9		69	CL	A-4 (4)				0.72	790 @ 16.30%	7.9	0.0500			
24-6	2					23			8.3	111.2								
24-6	4				-0.8				16.2	111.9								
24-7	1.25-3.5	NP	NP	NP		14	GM	A-1-a (0)				1.38		8.2	0.0200			
24-7	2					66			13.1	120.3								
24-7	4				-0.7				18.0	111.8								
G-1	0-1.5	NP	NP	NP		10	GP-GM	A-1-a (0)										
G-1	1.5-7	NP	NP	NP		40	SM	A-4 (0)				0.76	640 @ 16.30%	7.8	0.0500			
G-1	2				0.4				6.3	112.0								
G-1	4								16.1	106.3								
G-2	0.25-1.5	19	16	3		23	GM	A-1-b (0)										
G-2	2					61			12.0	104.9								
G-2	2.1-7	NP	NP	NP		68	ML	A-4 (0)				0.40	770 @ 17%	7.9	0.0400			
G-2	4				-0.1				15.8	114.5								
G-4	1.5-4																	

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
G-4	2				0.0				18.7	108.4								
G-4	4				-1.1				23.8	99.2								
G-5	0-4	24	18	6		12	GP-GC	A-1-a (0)				0.49	650 @ 17.30%	7.9	0.0345			
G-5	2	NP	NP	NP		36	SM	A-4 (0)	7.0	114.7								
G-5	4								5.6	124.6								
G-6	0-4	NP	NP	NP		50	GM	A-4 (0)				0.40		7.9	0.0400			
G-6	2				0.7				12.6	113.9								
G-6	4								8.7	114.2								
LC-1	0-5	25	18	7		75	CL-ML	A-4 (3)				0.16	190 @ 24.9%	8.6	0.1557			
LC-1	4					82			19.9	107.1								
LC-1	9	25	20	5	-0.6				25.1	93.1								
LC-1	14					92			27.9	97.8								
LC-1	19	25	16	9	-1.4				24.4	99.2								
LC-1	24					100			26.4	100.9								
LC-1	29								23.1	102.9								
LC-1	34	NP	NP	NP		12		A-2-4 (0)	23.8	101.0								
LC-1	39	NP	NP	NP		5	SP	A-3 (0)	15.7									
LC-1	48					81			10.4			0.45						
LC-1	49								10.1									
LC-2	2					93			20.1	105.5		1.32						
LC-2	4	24	18	6	-0.5				21.5	107.0								
LC-2	9								23.7	98.9		0.12						
LC-2	10					92												
LC-2	14	20	19	1	-0.3				22.4	106.0								
LC-2	24								18.3	72.7								
LC-2	34					29			16.2									
LC-2	44					12			23.5									
LC-2	49					76			7.5									
T-1	0-4	NP	NP	NP		44	SM	A-4 (0)				0.40		7.9	0.0400			
T-1	4				0.4				14.2	110.7								

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
T-1	9				-0.3				26.8	98.2								
T-1	14					77			24.9	150.8								
T-1	24								25.9	95.4		0.13						
T-1	34					85			23.4	105.6								
T-1	45					76			22.7									
T-1	46					19			7.8									
T-2	4	21	18	3		87	ML	A-4 (0)	23.2									
T-2	9								27.1			0.08						
T-2	14				-1.0				26.7	94.7								
T-2	19					96			27.9	95.3								
T-2	29								23.5	98.4								
T-2	39	NP	NP	NP		10		A-3 (0)	6.8									
T-2	60					52			13.5			0.33						
T-3	4				-0.7				25.2	97.1								
T-3	9				-2.3				29.1	95.3								
T-3	14				-2.4				25.2	100.1								
T-3	19					98			28.1	91.6								
T-3	29								26.1	93.5								
T-3	39	NP	NP	NP		7	GP-GM	A-1-a (0)	5.3									
T-3	53-72	27	15	12		55	CL	A-6 (4)				0.24						
T-3	63								2.3									
T-3	72								12.1									
UP-1	4					99			25.3	98.0								
UP-1	9								24.1	102.5		0.45						
UP-1	14				-0.2				23.2	109.4								
UP-1	19				-3.9				27.8	97.5								
UP-1	29								21.1	108.2								
UP-2	0-4	26	16	10		75	CL	A-4 (5)				0.40		7.9	0.0400			
UP-2	2					20			9.6	98.9								
UP-2	4					80			23.2	96.2		0.36						

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO

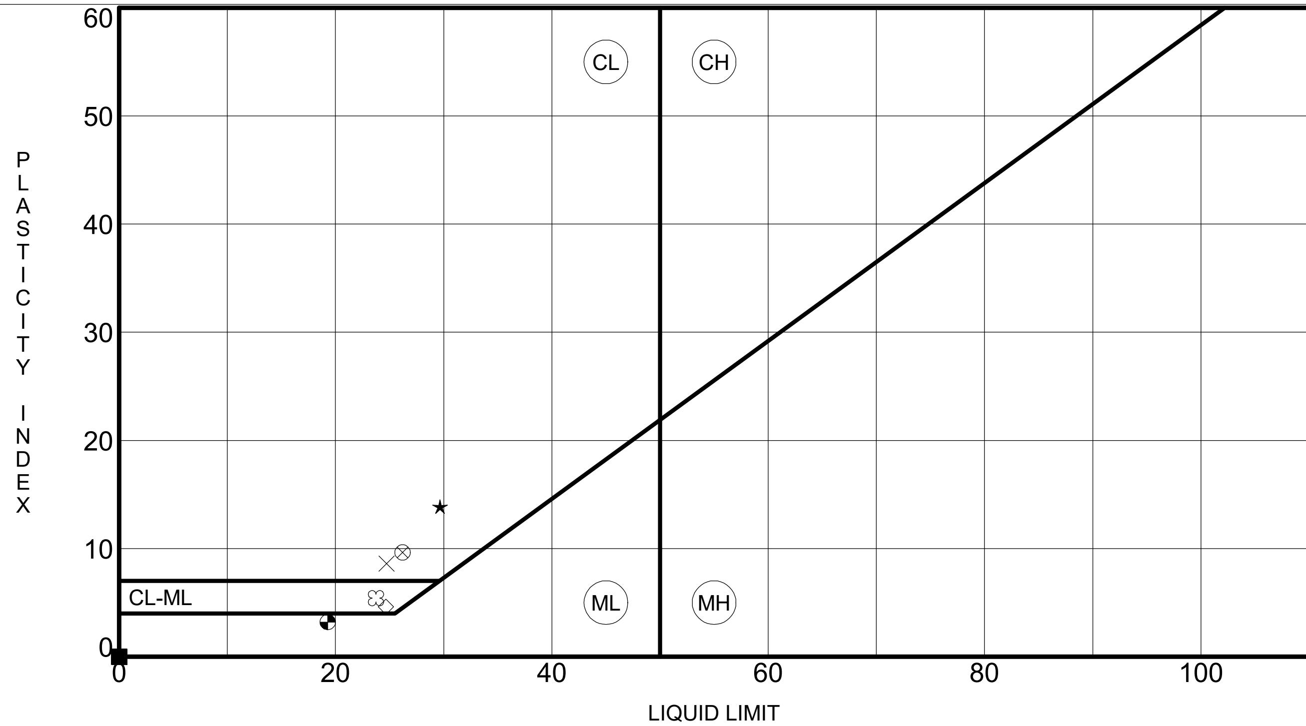
Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
UP-2	9				-3.3				23.0	100.1								
UP-2	14				-0.1				26.5	100.5								
UP-2	19				-0.5				26.6	99.8								
UP-2	24								27.6	98.6								

ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



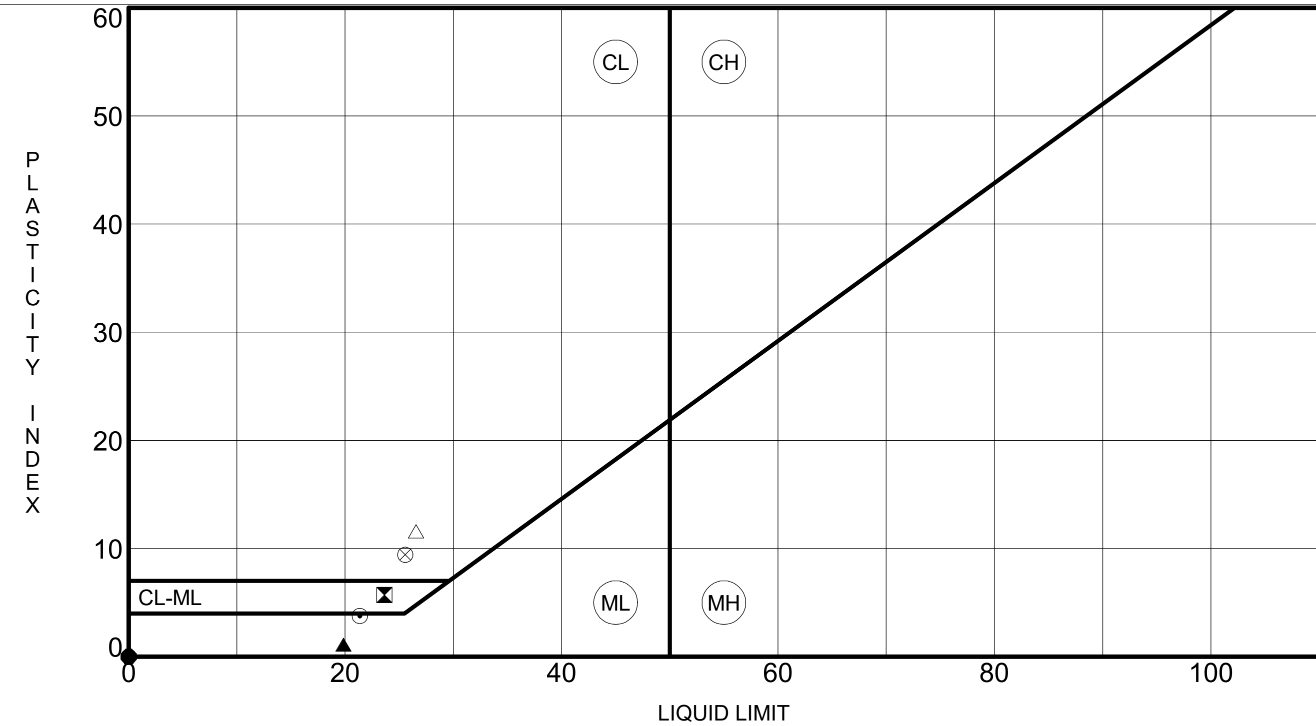
	Specimen Identification		LL	PL	PI	Fines	Classification
●	**24-1**	**0.7-4.0**	**NP**	**NP**	**NP**	**17.8**	**SILTY GRAVEL with SAND (GM) (A-1-b)**
⧗	**24-1**	**2.0**	**NP**	**NP**	**NP**	**11.8**	**(Fill) SAND, slightly silty to gravelly (A-2-4)**
▲	**24-2**	**0.0-1.0**	**NP**	**NP**	**NP**	**18.5**	**SILTY GRAVEL with SAND (GM) (A-1-b)**
★	**24-2**	**1.0-4.0**	**30**	**16**	**14**	**78.5**	**LEAN CLAY with SAND (CL) (A-6)**
⊙	**24-3**	**0.7-2.5**	**NP**	**NP**	**NP**	**16.0**	**SILTY SAND with GRAVEL (SM) (A-1-b)**
✿	**24-3**	**2.5-4.0**	**NP**	**NP**	**NP**	**40.9**	**SILTY SAND (SM) (A-4)**
○	**24-4**	**0.7-2.0**	**NP**	**NP**	**NP**	**15.1**	**SILTY GRAVEL with SAND (GM) (A-1-b)**
△	**24-4**	**2.1-4.0**	**NP**	**NP**	**NP**	**60.7**	**SANDY SILT (ML) (A-4)**
⊗	**24-6**	**0.0-4.0**	**26**	**17**	**9**	**68.8**	**SANDY LEAN CLAY (CL) (A-4)**
⊕	**24-7**	**1.3-3.5**	**NP**	**NP**	**NP**	**14.1**	**SILTY GRAVEL with SAND (GM) (A-1-a)**
□	**G-1**	**0.0-1.5**	**NP**	**NP**	**NP**	**10.0**	**POORLY GRADED GRAVEL with SILT and SAND (GP-GM) (A-1-a)**
⊖	**G-1**	**1.5-7.0**	**NP**	**NP**	**NP**	**40.0**	**SILTY SAND (SM) (A-4)**
◕	**G-2**	**0.3-1.5**	**19**	**16**	**3**	**23.3**	**SILTY GRAVEL with SAND (GM) (A-1-b)**
☆	**G-2**	**2.1-7.0**	**NP**	**NP**	**NP**	**68.2**	**SANDY SILT (ML) (A-4)**
✾	**G-5**	**0.0-4.0**	**24**	**18**	**6**	**11.9**	**POORLY GRADED GRAVEL with SILTY CLAY (GP-GC) (A-1-a)**
■	**G-5**	**2.0**	**NP**	**NP**	**NP**	**35.7**	**(Fill) SAND, gravelly w silt and trace clay, w cobbles (A-4)**
◆	**G-6**	**0.0-4.0**	**NP**	**NP**	**NP**	**50.0**	**SILTY GRAVEL with SAND (GM) (A-4)**
◇	**LC-1**	**9.0**	**25**	**20**	**5**		**CLAY, silty to sandy**
×	**LC-1**	**19.0**	**25**	**16**	**9**		**CLAY, silty to sandy**
✖	**LC-1**	**34.0**	**NP**	**NP**	**NP**	**12.3**	**SAND, with gravel (A-2-4)**

ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



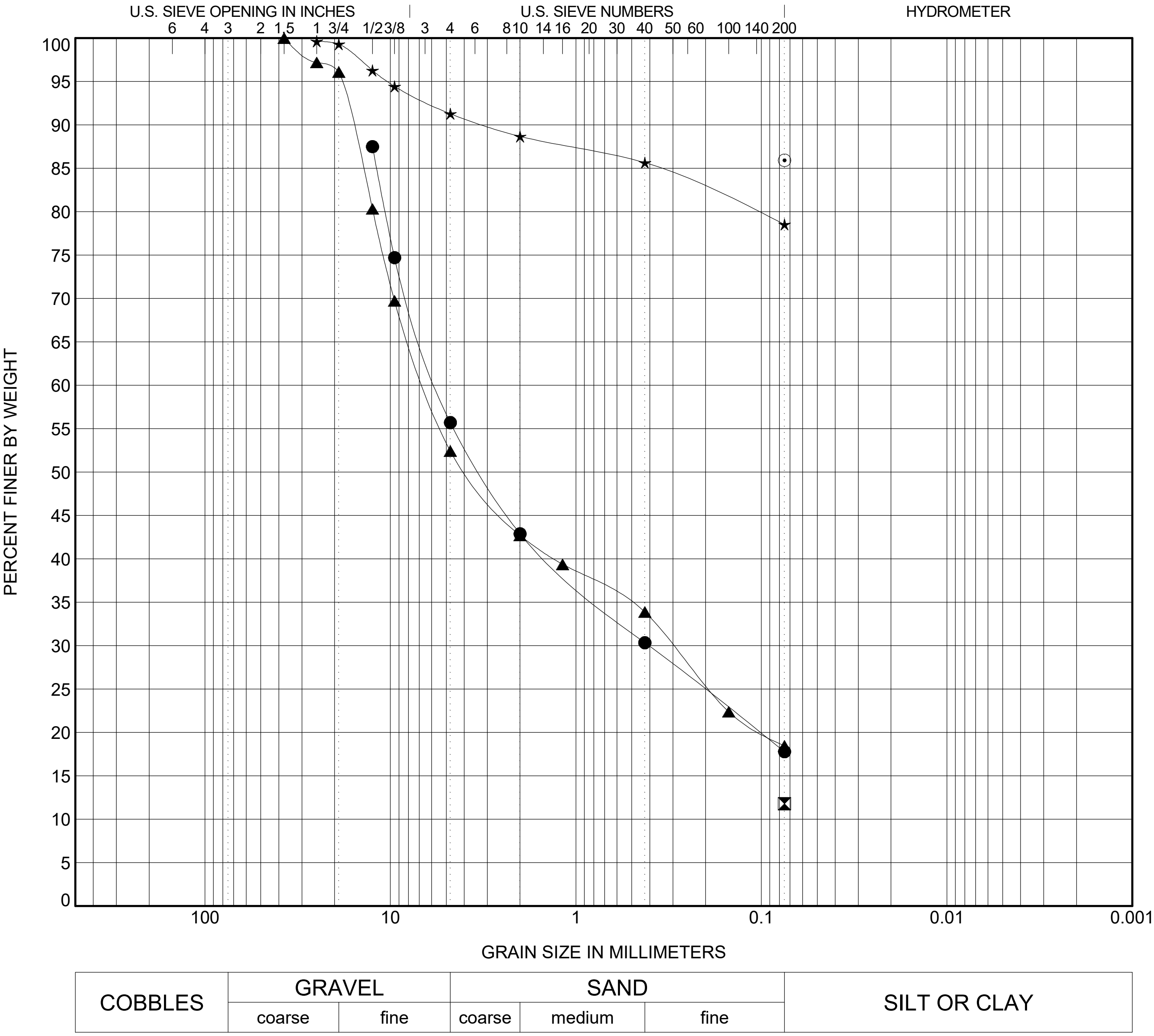
	Specimen Identification		LL	PL	PI	Fines	Classification
●	LC-1	39.0	NP	NP	NP	4.7	POORLY GRADED SAND with GRAVEL (SP) (A-3)
⧗	LC-2	4.0	24	18	6		CLAY, sandy to silty
▲	LC-2	14.0	20	19	1		CLAY, sandy to silty
★	T-1	0.0-4.0	NP	NP	NP	43.6	SILTY SAND with GRAVEL (SM) (A-4)
⊙	T-2	4.0	21	18	3	87.4	SILT (ML) (A-4)
✿	T-2	39.0	NP	NP	NP	10.3	GRAVEL, sandy to silty with cobbles (A-3)
○	T-3	39.0	NP	NP	NP	7.3	GRAVEL, sandy with cobbles (A-1-a)
△	T-3	53.0-72.0	27	15	12	55.4	(Bedrock) SHALE/CLAYSTONE (A-6)
⊗	UP-2	0.0-4.0	26	16	10	75.4	LEAN CLAY with SAND (CL) (A-4)

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07 **CLIENT PROJECT NUMBER** Grand Junction, CO



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**24-1**	**0.7-4**	**SILTY GRAVEL with SAND (GM) (A-1-b)**	**NP**	**NP**	**NP**		
⧗	**24-1**	**2.0**	**(Fill) SAND, slightly silty to gravelly (A-2-4)**	**NP**	**NP**	**NP**		
▲	**24-2**	**0.0-1**	**SILTY GRAVEL with SAND (GM) (A-1-b)**	**NP**	**NP**	**NP**		
★	**24-2**	**1.0-4**	**LEAN CLAY with SAND (CL) (A-6)**	**30**	**16**	**14**		
⊙	**24-2**	**2.0**	**CLAY, with sand, silty**					

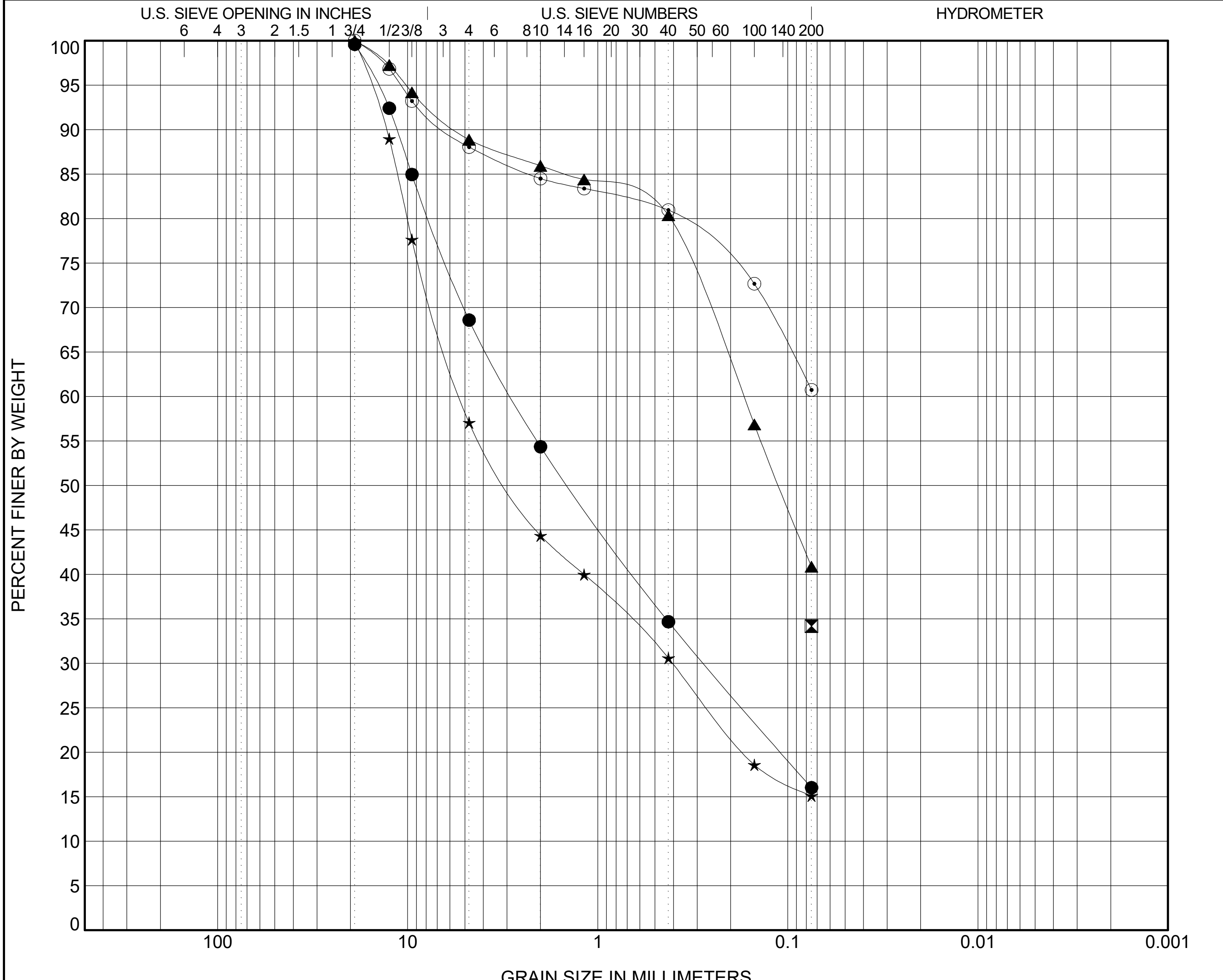
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**24-1**	**0.7-4**	**12.5**	**5.557**	**0.406**		**31.8**	**37.9**	**17.8**	
⧗	**24-1**	**2.0**	**0.075**						**11.8**	
▲	**24-2**	**0.0-1**	**37.5**	**6.434**	**0.299**		**47.6**	**34.0**	**18.5**	
★	**24-2**	**1.0-4**	**25**				**8.4**	**12.8**	**78.5**	
⊙	**24-2**	**2.0**	**0.075**						**85.9**	

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07 **CLIENT PROJECT NUMBER** Grand Junction, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

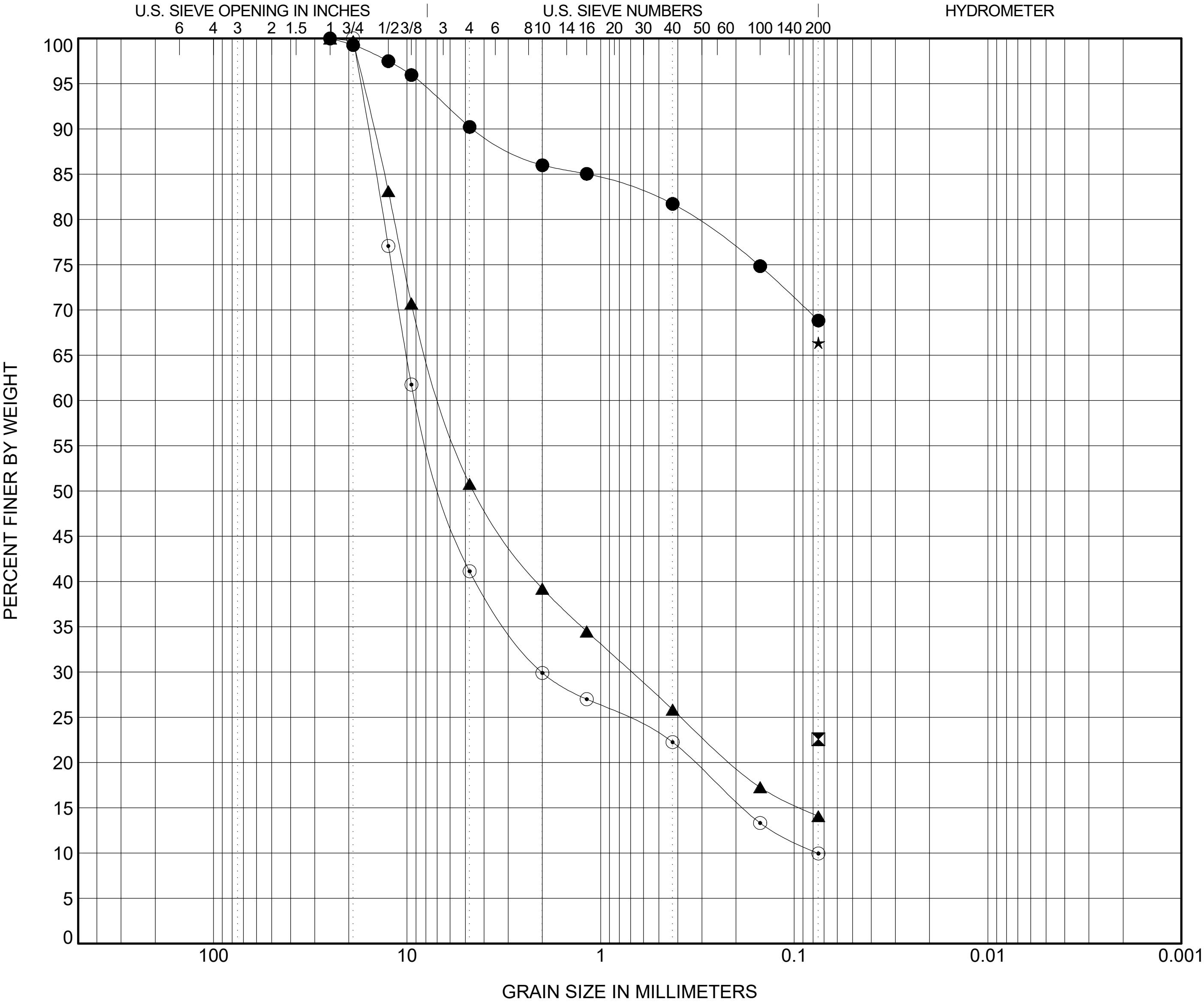
	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	24-3	0.7-3	**SILTY SAND with GRAVEL (SM) (A-1-b)**	NP	NP	NP		
⧗	24-3	2.0	**(ABC) SAND, slightly silty to gravelly w CLAY**					
▲	24-3	2.5-4	**SILTY SAND (SM) (A-4)**	NP	NP	NP		
★	24-4	0.7-2	**SILTY GRAVEL with SAND (GM) (A-1-b)**	NP	NP	NP		
⊙	24-4	2.1-4	**SANDY SILT (ML) (A-4)**	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	24-3	0.7-3	19	2.818	0.275		31.0	52.6	16.0	
⧗	24-3	2.0	0.075						34.2	
▲	24-3	2.5-4	19	0.172			11.1	48.0	40.9	
★	24-4	0.7-2	19	5.244	0.404		42.9	41.9	15.1	
⊙	24-4	2.1-4	19				12.0	27.3	60.7	

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
ROCKSOL PROJECT NUMBER 599.07
CLIENT PROJECT NUMBER Grand Junction, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	24-6	0.0-4	SANDY LEAN CLAY (CL) (A-4)	26	17	9		
⧗	24-6	2.0	(Fill) SAND, silty to gravelly in parts, CLAY lenses in parts					
▲	24-7	1.3-4	SILTY GRAVEL with SAND (GM) (A-1-a)	NP	NP	NP		
★	24-7	2.0	(Fill) SAND, gravelly w SILT lenses in parts					
⊙	G-1	0.0-2	POORLY GRADED GRAVEL with SILT and SAND (GP-GM) (A-1-a)	NP	NP	NP	5.99	118.24

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	24-6	0.0-4	25				9.8	21.4	68.8	
⧗	24-6	2.0	0.075						22.6	
▲	24-7	1.3-4	25	6.542	0.694		49.2	36.7	14.1	
★	24-7	2.0	0.075						66.4	
⊙	G-1	0.0-2	19	8.954	2.016	0.076	58.9	31.2	10.0	

GRAIN SIZE DISTRIBUTION

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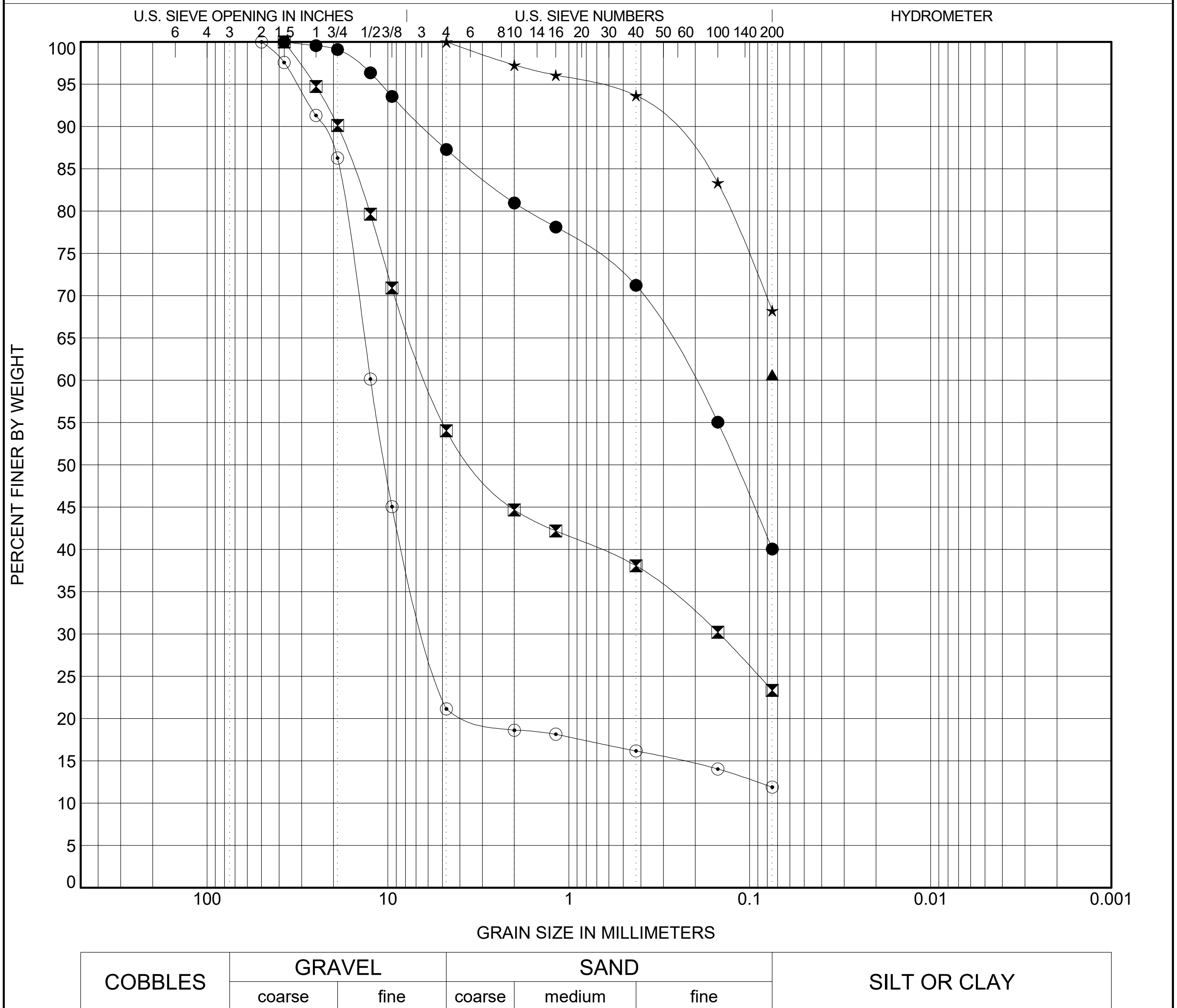
CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07 **CLIENT PROJECT NUMBER** Grand Junction, CO



Symbol	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**G-1**	**1.5-7**	**SILTY SAND (SM) (A-4)**	**NP**	**NP**	**NP**		
⧗	**G-2**	**0.3-2**	**SILTY GRAVEL with SAND (GM) (A-1-b)**	**19**	**16**	**3**		
▲	**G-2**	**2.0**	**SAND, silty to slightly clayey in parts**					
★	**G-2**	**2.1-7**	**SANDY SILT (ML) (A-4)**	**NP**	**NP**	**NP**		
⊙	**G-5**	**0.0-4**	**POORLY GRADED GRAVEL with SILTY CLAY (GP-GC) (A-1-a)**	**24**	**18**	**6**	**74.38**	**306.71**

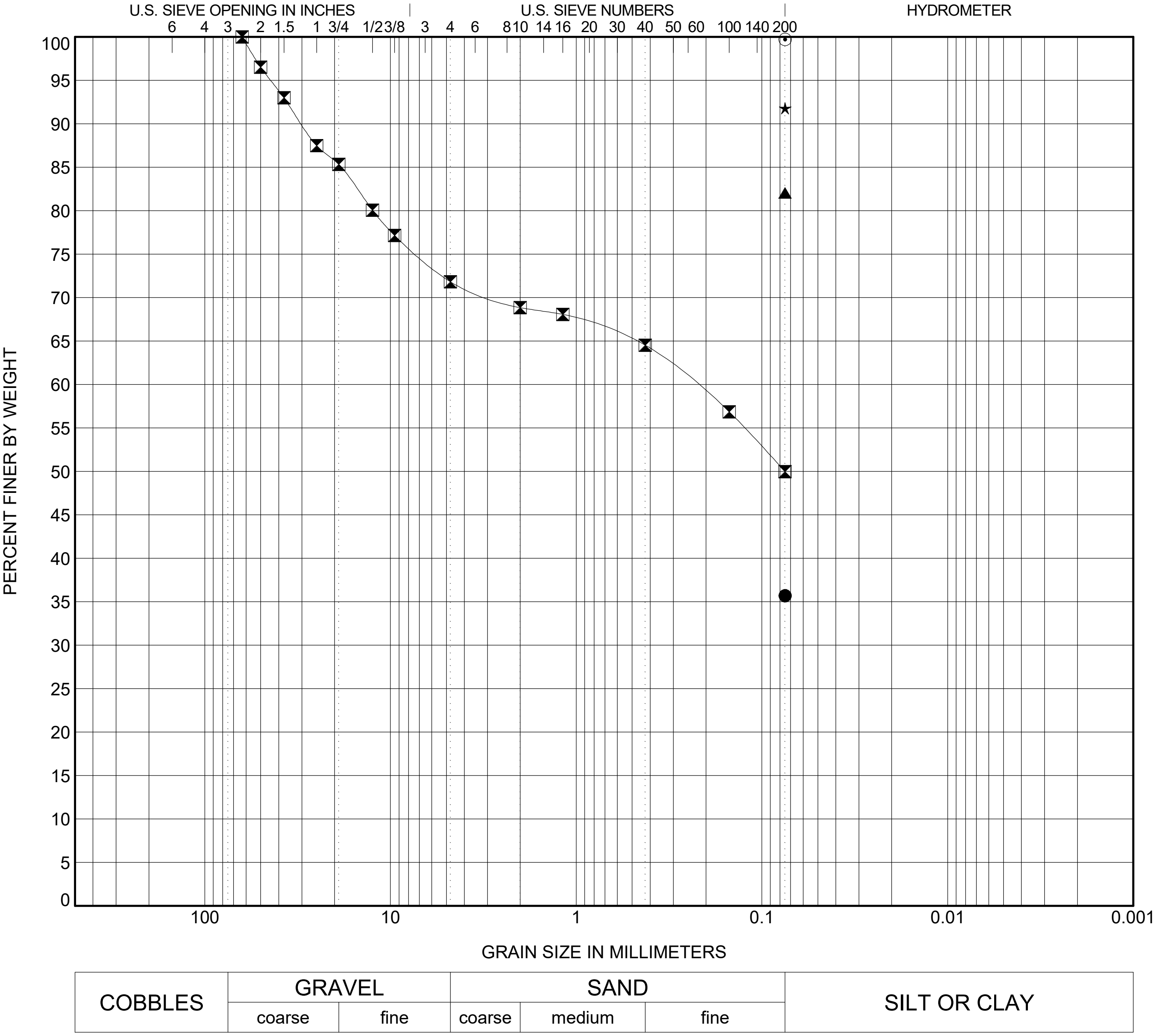
Symbol	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt / %Clay
●	**G-1**	**1.5-7**	**37.5**	**0.206**			**12.7**	**47.2**	**40.0**
⧗	**G-2**	**0.3-2**	**37.5**	**6.068**	**0.147**		**46.0**	**30.7**	**23.3**
▲	**G-2**	**2.0**	**0.075**						**60.6**
★	**G-2**	**2.1-7**	**4.75**				**0.0**	**31.8**	**68.2**
⊙	**G-5**	**0.0-4**	**50**	**12.468**	**6.14**		**78.9**	**9.3**	**11.9**

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07 **CLIENT PROJECT NUMBER** Grand Junction, CO



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	G-5	2.0	(Fill) SAND, gravelly w silt and trace clay, w cobbles (A-4)	NP	NP	NP		
⧗	G-6	0.0-4	SILTY GRAVEL with SAND (GM) (A-4)	NP	NP	NP		
▲	LC-1	4.0	CLAY, silty to sandy					
★	LC-1	14.0	CLAY, silty to sandy					
⊙	LC-1	24.0	CLAY, silty to sandy					

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	G-5	2.0	0.075						35.7	
⧗	G-6	0.0-4	63	0.23			28.2	21.8	50.0	
▲	LC-1	4.0	0.075						82.0	
★	LC-1	14.0	0.075						91.8	
⊙	LC-1	24.0	0.075						99.7	

GRADATION - CLIENT STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 11/5/20

GRAIN SIZE DISTRIBUTION

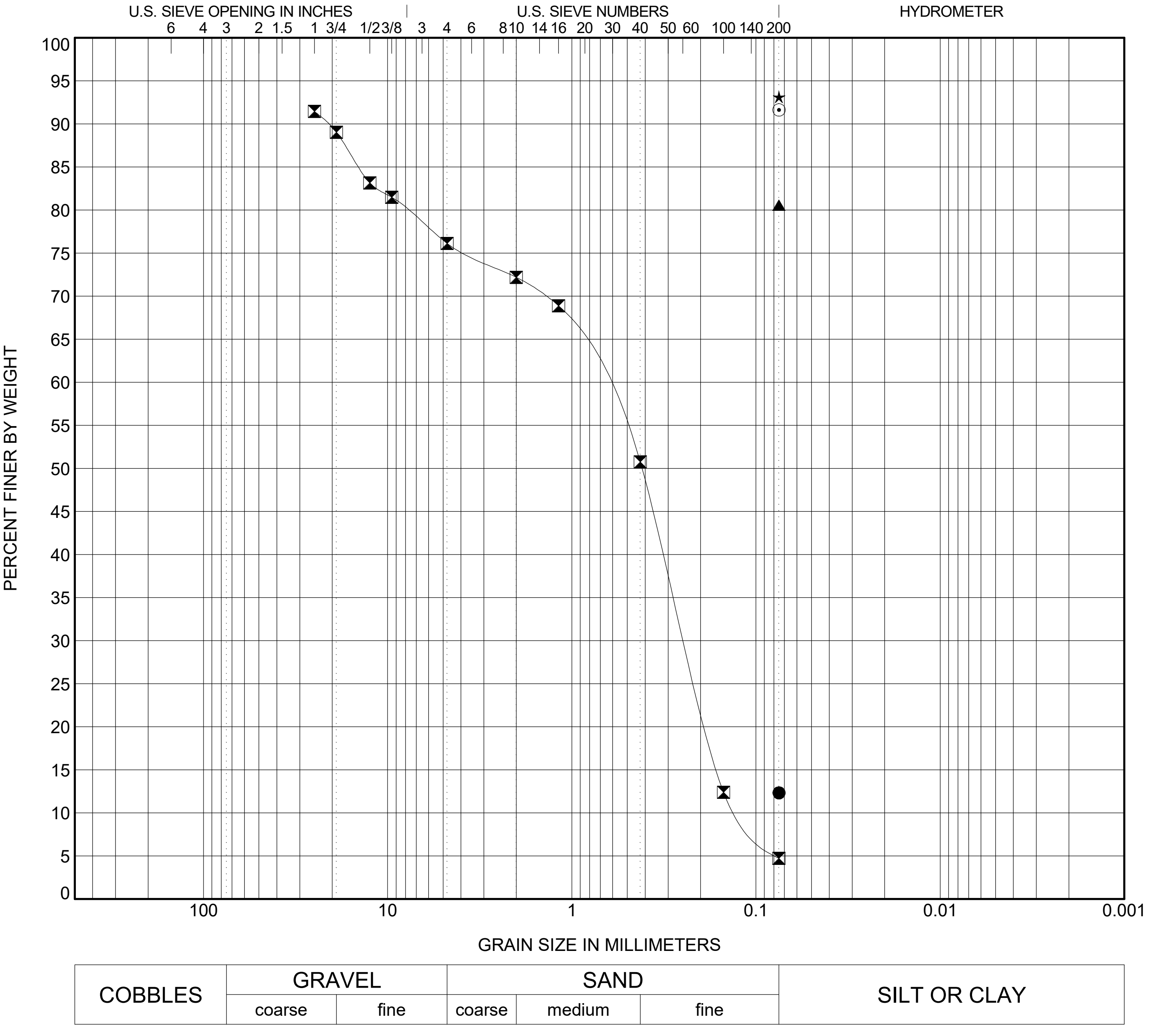
RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07

CLIENT PROJECT NUMBER Grand Junction, CO



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	LC-1	34.0	**SAND, with gravel (A-2-4)**	NP	NP	NP		
⧗	LC-1	39.0	**POORLY GRADED SAND with GRAVEL (SP) (A-3)**	NP	NP	NP	0.68	5.92
▲	LC-1	48.0	**(Bedrock) CLAYSTONE/SHALE**					
★	LC-2	2.0	**CLAY, sandy to silty**					
⊙	LC-2	10.0	**CLAY, sandy to silty**					

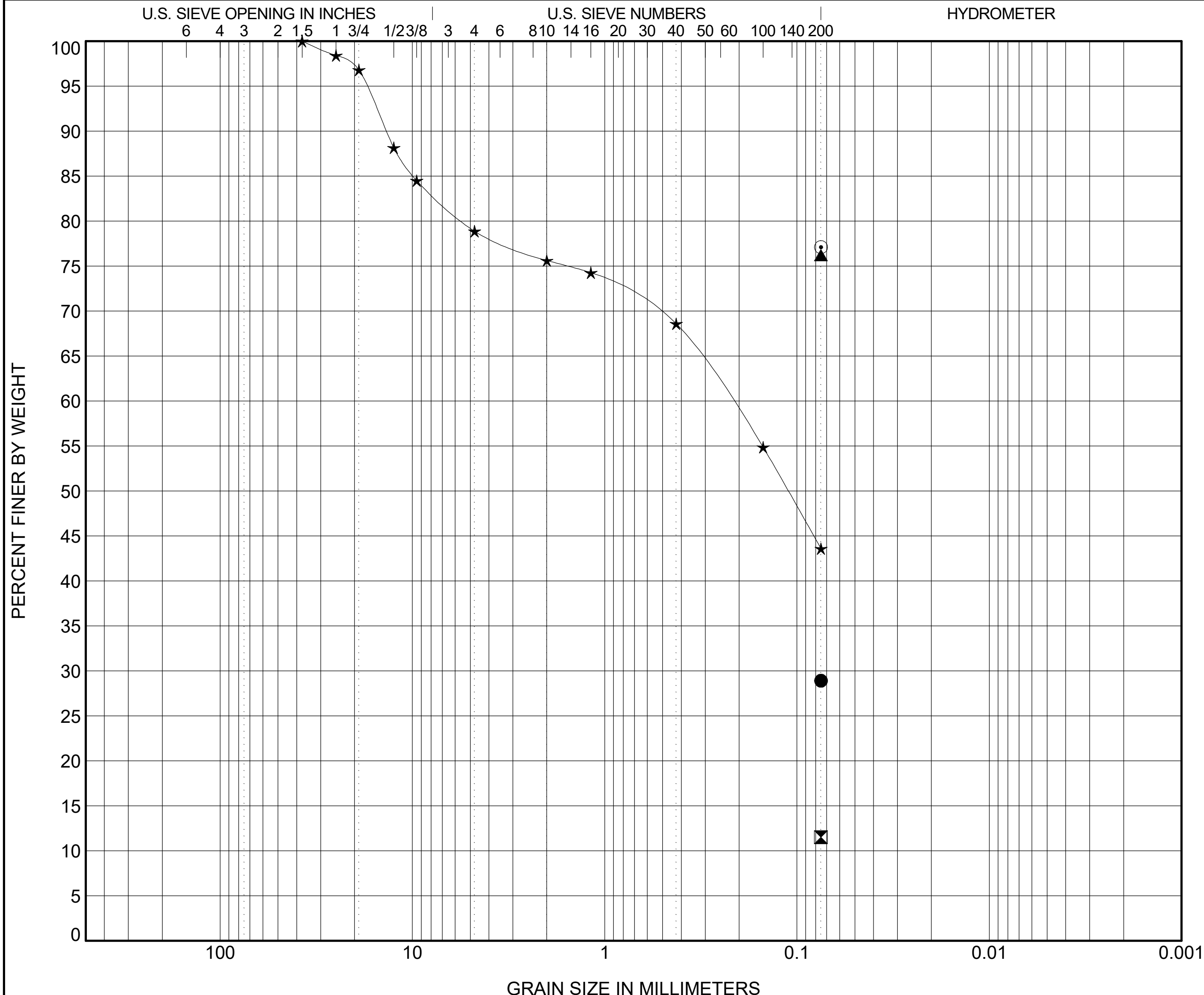
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	LC-1	34.0	0.075						12.3	
⧗	LC-1	39.0	25	0.715	0.242	0.121	15.3	71.4	4.7	
▲	LC-1	48.0	0.075						80.6	
★	LC-2	2.0	0.075						93.1	
⊙	LC-2	10.0	0.075						91.6	

GRADATION - CLIENT STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 11/5/20

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
ROCKSOL PROJECT NUMBER 599.07
CLIENT PROJECT NUMBER Grand Junction, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	LC-2	34.0	**SAND, with cobbles**					
⧗	LC-2	44.0	**(Bedrock) CLAYSTONE/SHALE**					
▲	LC-2	49.0	**(Bedrock) CLAYSTONE/SHALE**					
★	T-1	0.0-4	**SILTY SAND with GRAVEL (SM) (A-4)**	NP	NP	NP		
⊙	T-1	14.0	**CLAY, sandy to silty w SAND lenses in parts**					

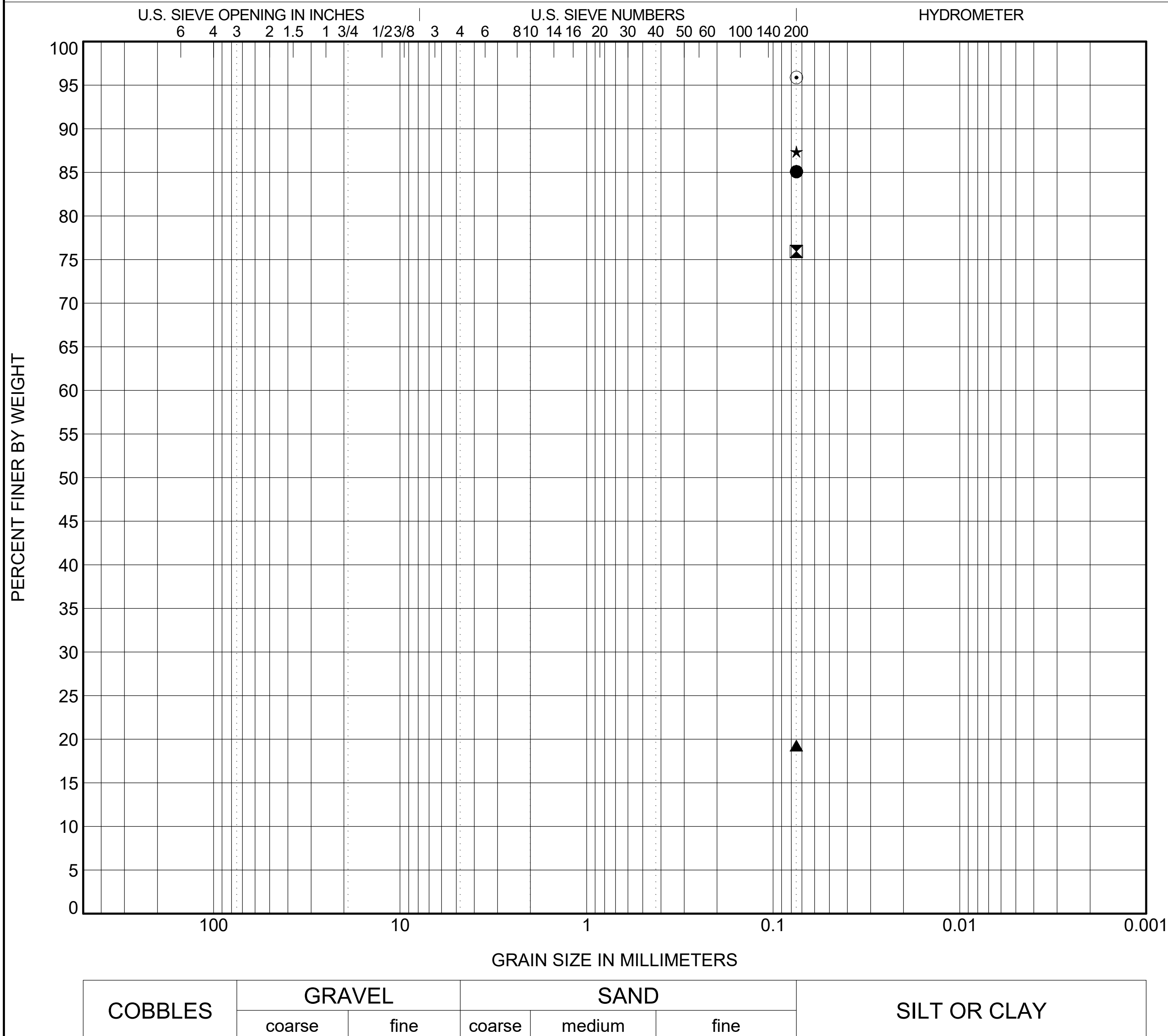
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	LC-2	34.0	0.075						28.9	
⧗	LC-2	44.0	0.075						11.5	
▲	LC-2	49.0	0.075						76.2	
★	T-1	0.0-4	37.5	0.221			21.1	35.3	43.6	
⊙	T-1	14.0	0.075						77.1	

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07 **CLIENT PROJECT NUMBER** Grand Junction, CO



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**T-1**	**34.0**	**CLAY, sandy to silty w SAND lenses in parts**					
⧗	**T-1**	**45.0**	**CLAY, sandy (weathered CLAYSTONE)**					
▲	**T-1**	**46.0**	**CLAYSTONE, sandy**					
★	**T-2**	**4.0**	**SILT (ML) (A-4)**	**21**	**18**	**3**		
⊙	**T-2**	**19.0**	**CLAY, w silt**					

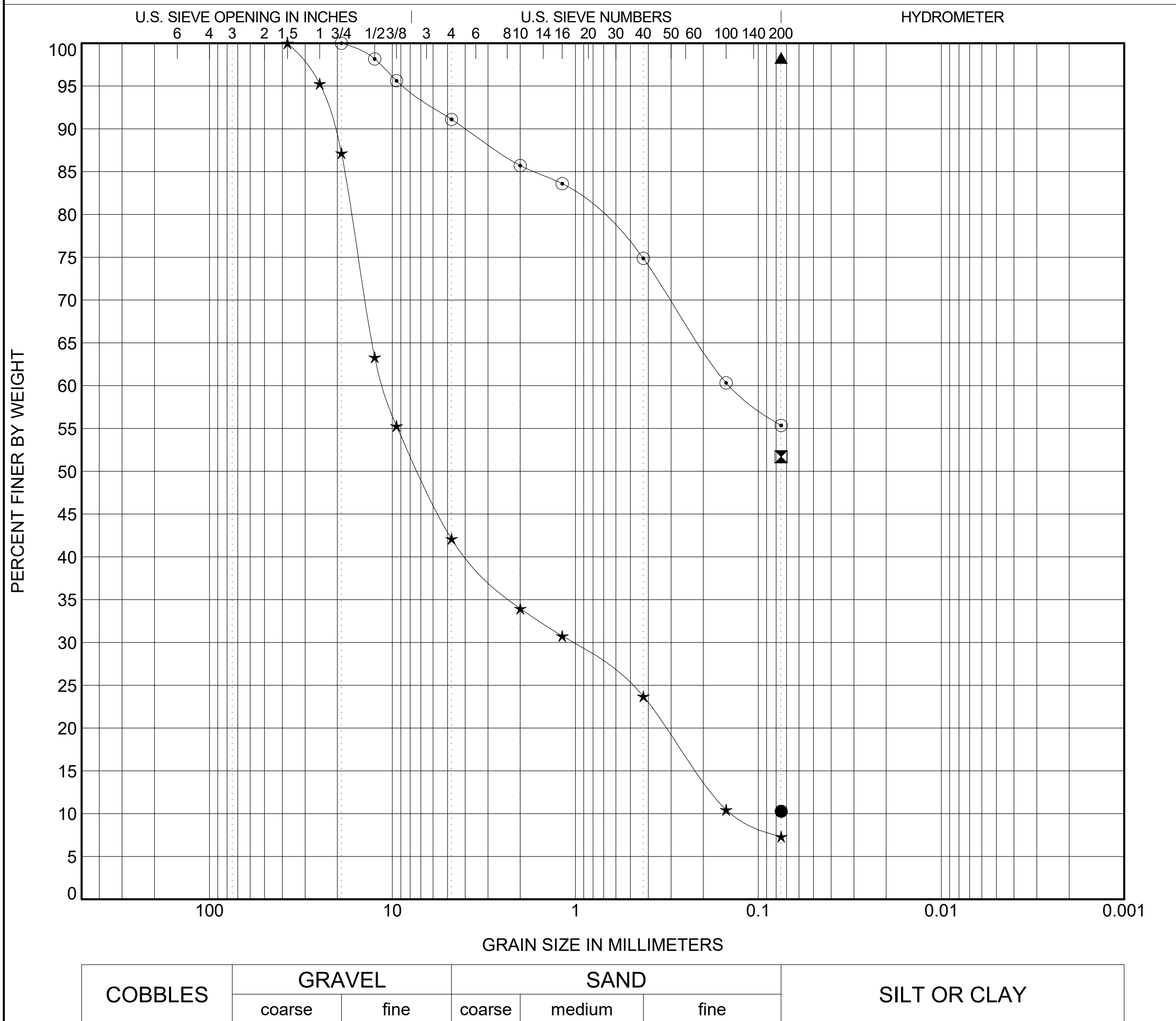
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T-1**	**34.0**	**0.075**						**85.1**	
⧗	**T-1**	**45.0**	**0.075**						**75.9**	
▲	**T-1**	**46.0**	**0.075**						**19.3**	
★	**T-2**	**4.0**	**0.075**						**87.4**	
⊙	**T-2**	**19.0**	**0.075**						**95.9**	

GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07 **CLIENT PROJECT NUMBER** Grand Junction, CO



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	T-2	39.0	**GRAVEL, sandy to silty with cobbles (A-3)**	NP	NP	NP		
⧗	T-2	60.0	**(Bedrock) SHALE/CLAYSTONE**					
▲	T-3	19.0	**CLAY, silty**					
★	T-3	39.0	**GRAVEL, sandy with cobbles (A-1-a)**	NP	NP	NP	0.74	82.30
⊙	T-3	53.0-72	**(Bedrock) SHALE/CLAYSTONE (A-6)**	27	15	12		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt / %Clay
●	T-2	39.0	0.075						10.3
⧗	T-2	60.0	0.075						51.7
▲	T-3	19.0	0.075						98.3
★	T-3	39.0	37.5	11.156	1.057	0.136	57.9	34.8	7.3
⊙	T-3	53.0-72	19	0.143			8.9	35.8	55.4

GRADATION - CLIENT STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 11/5/20

GRAIN SIZE DISTRIBUTION

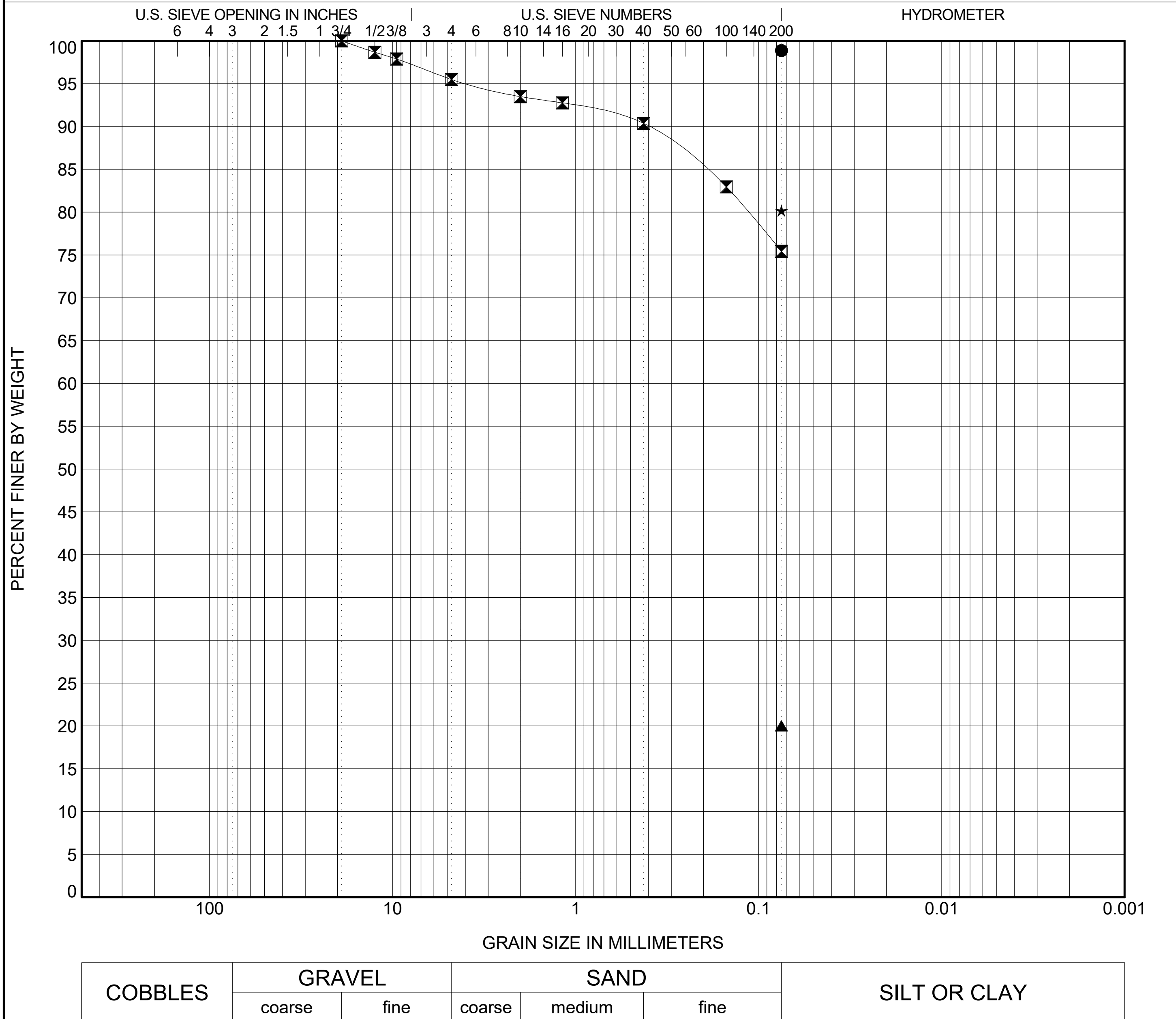
RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

ROCKSOL PROJECT NUMBER 599.07

CLIENT PROJECT NUMBER Grand Junction, CO



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**UP-1**	**4.0**	**CLAY, silty**					
⧗	**UP-2**	**0.0-4**	**LEAN CLAY with SAND (CL) (A-4)**	**26**	**16**	**10**		
▲	**UP-2**	**2.0**	**SAND, silty to slightly clayey in parts**					
★	**UP-2**	**4.0**	**CLAY, silty w silty SAND lenses in parts**					

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**UP-1**	**4.0**	**0.075**						**98.9**	
⧗	**UP-2**	**0.0-4**	**19**				**4.5**	**20.0**	**75.4**	
▲	**UP-2**	**2.0**	**0.075**						**20.0**	
★	**UP-2**	**4.0**	**0.075**						**80.2**	

GRADATION - CLIENT STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 11/5/20

SWELL - CONSOLIDATION TEST

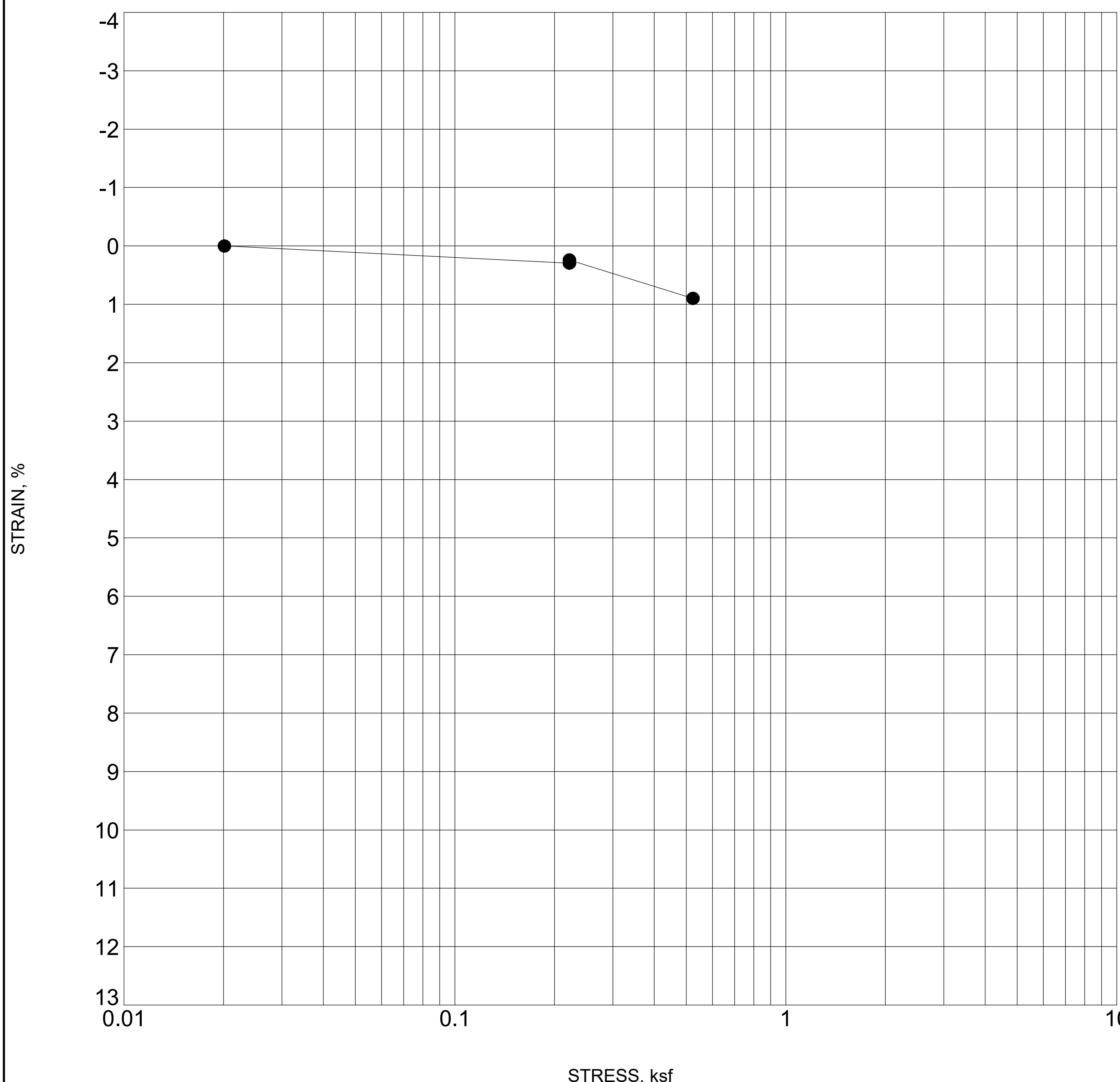
RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● 24-2	4	CLAY, with sand	0.1	104.1	17.7

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

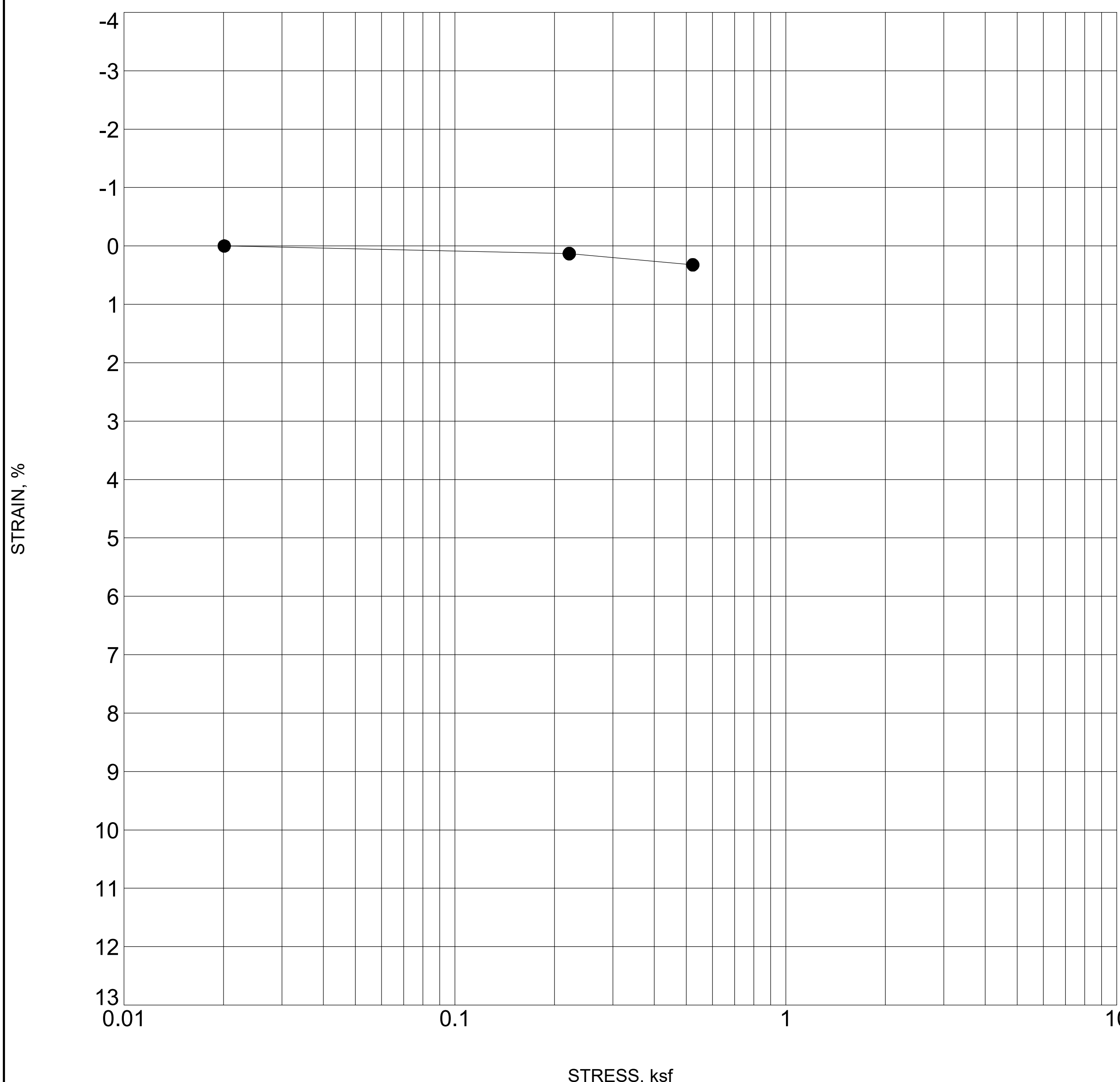
RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● 24-4	2	SILT, sandy w clayey SAND in parts	0.0	127.5	10.0

SWELL - CONSOLIDATION TEST

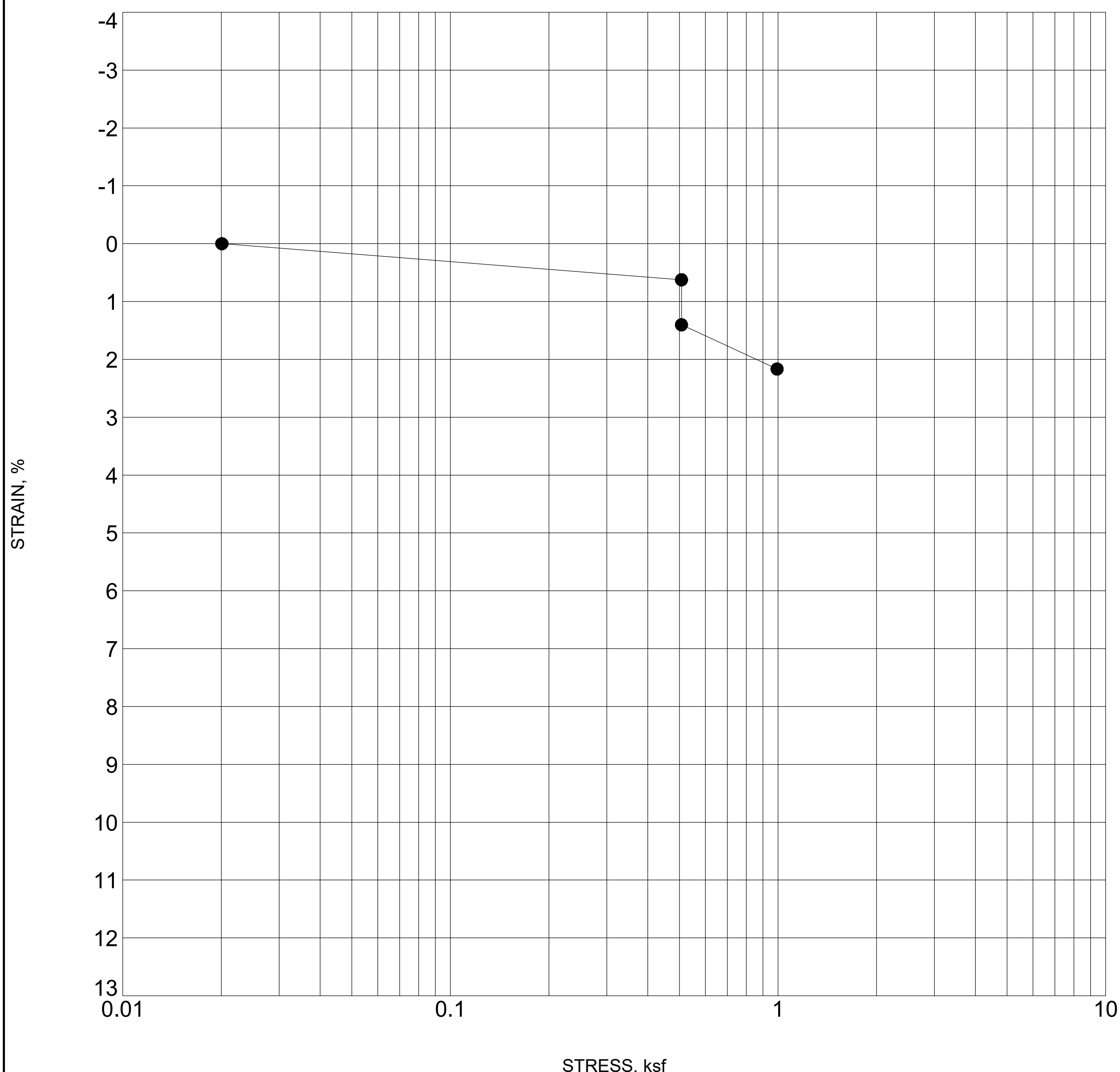
RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO



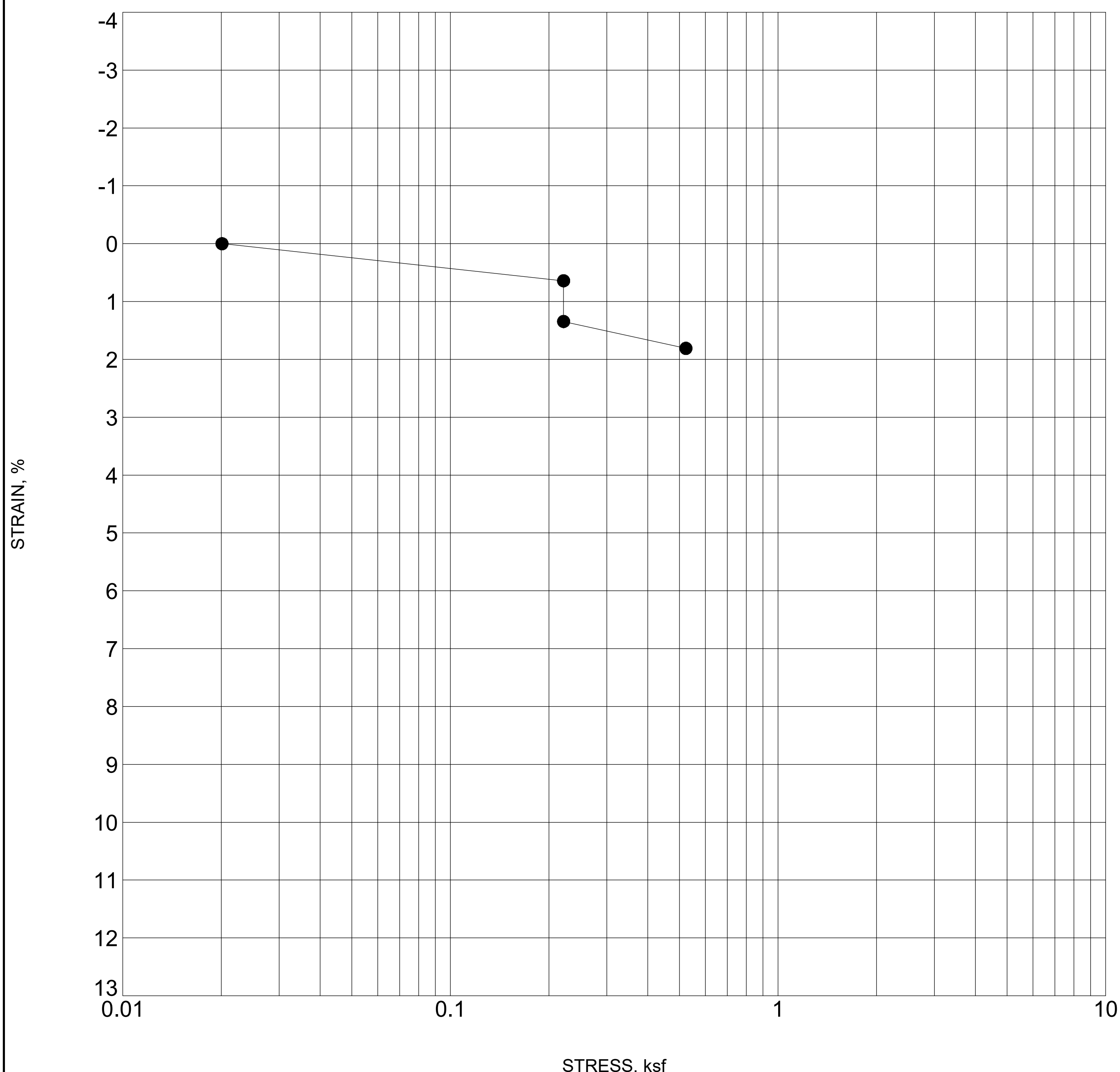
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **24-6**	**4**	**SAND, clayey to silty**	**-0.8**	**111.9**	**16.2**

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO

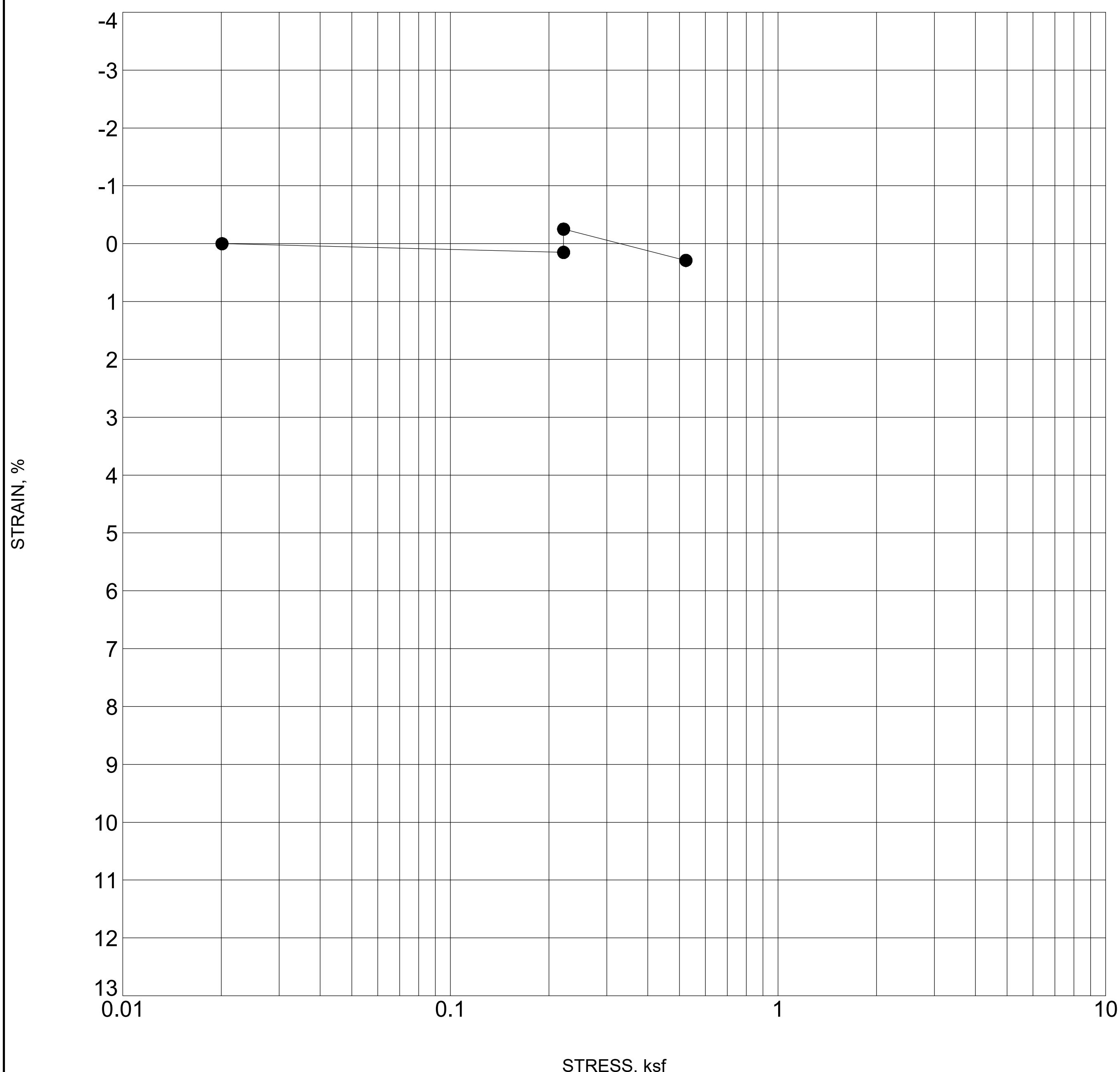


Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● 24-7	4	**CLAY, sandy**	**-0.7**	**111.8**	**18.0**

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO



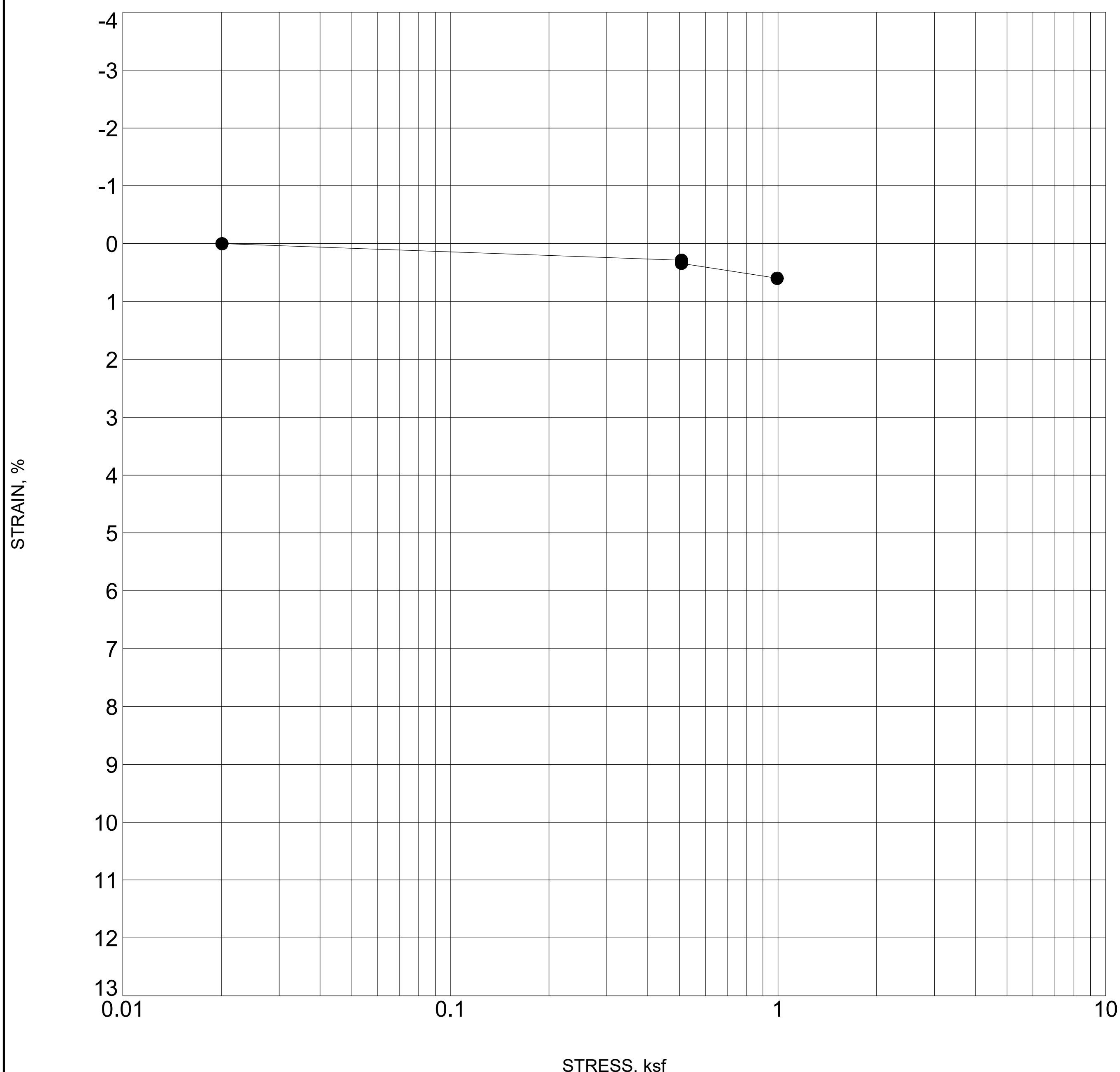
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● G-1	2	**SAND, silty, fine to coarse grained**	**0.4**	**112.0**	**6.3**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● G-2	4	**SAND, silty to slightly clayey in parts**	**-0.1**	**114.5**	**15.8**

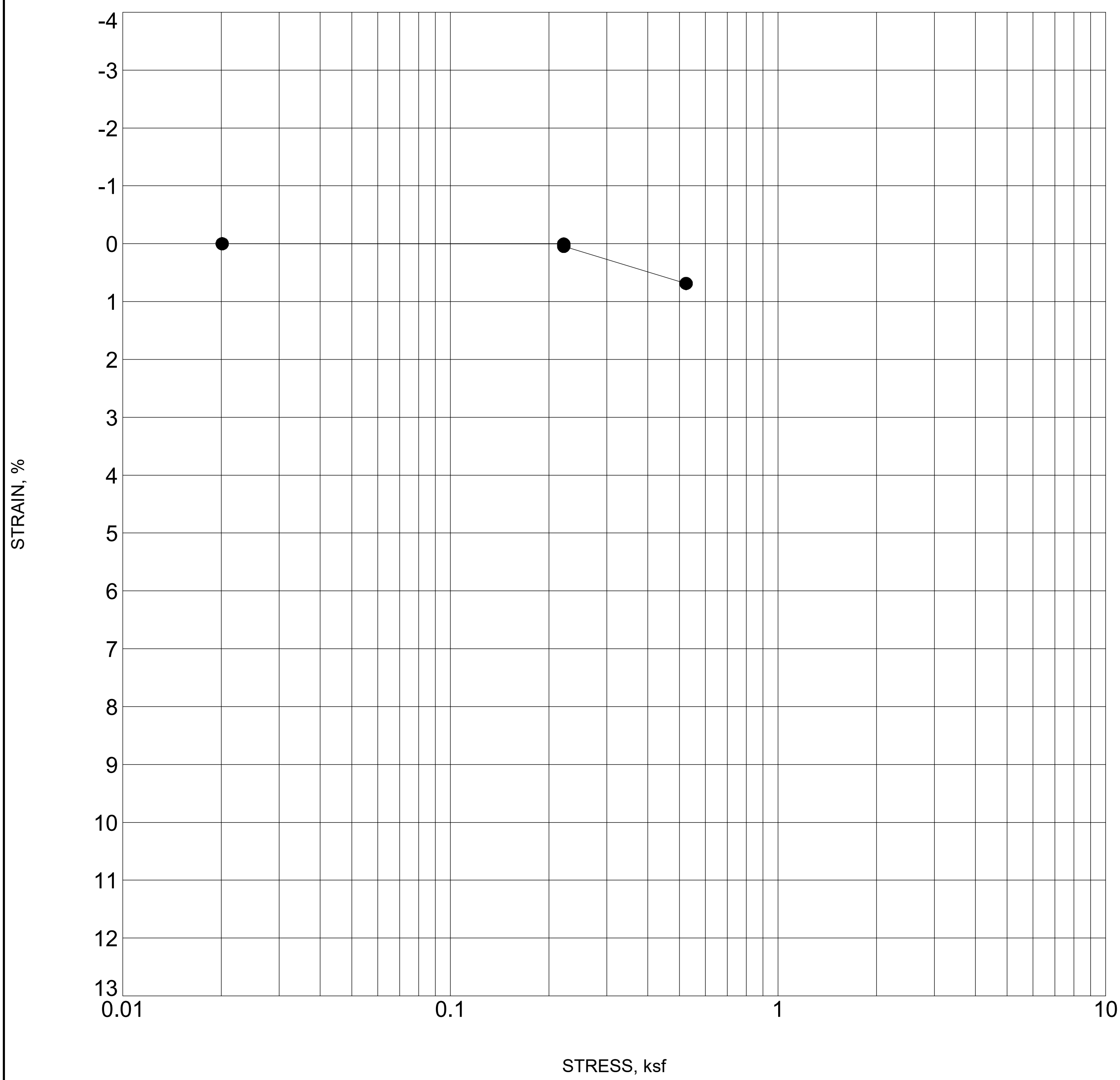
SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction | **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 | **PROJECT LOCATION** Grand Junction, CO

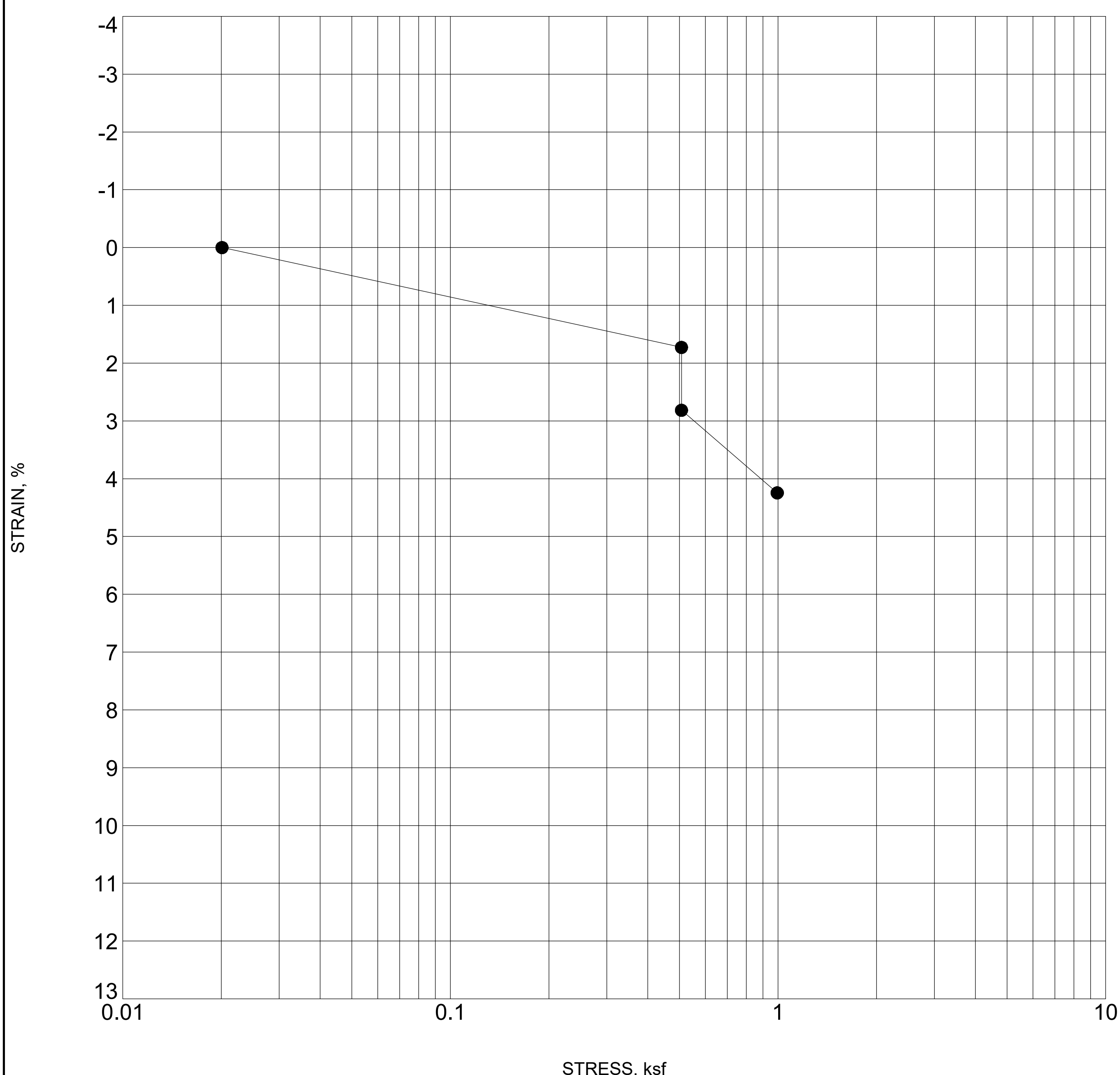


Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● G-4	2	**SAND, silty to slightly clayey in parts**	**0.0**	**108.4**	**18.7**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO



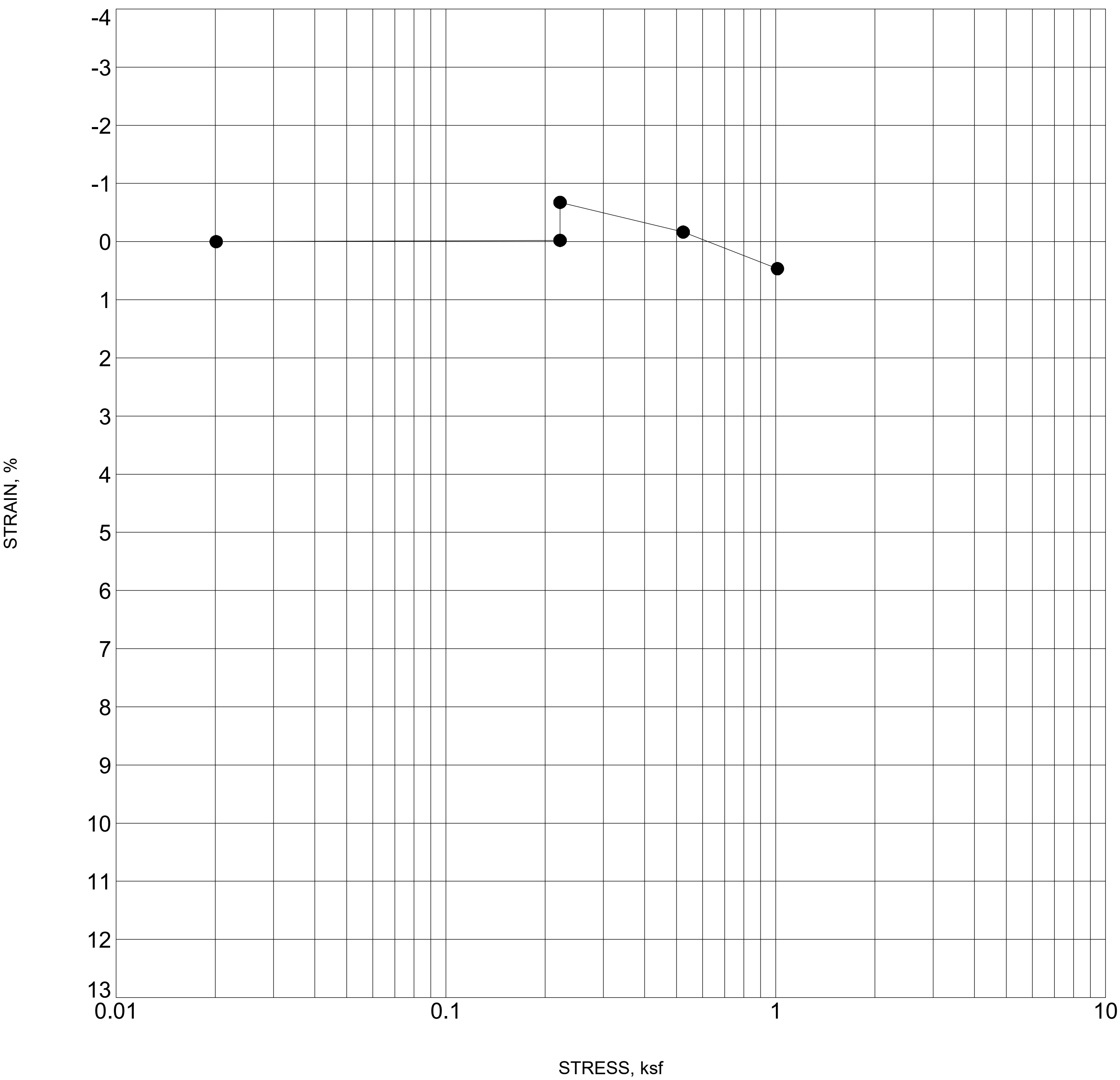
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● G-4	4	**SAND, silty w sandy CLAY lenses in parts**	**-1.1**	**99.2**	**23.8**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● G-6	2	CLAY, sandy w silt	0.7	113.9	12.6

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

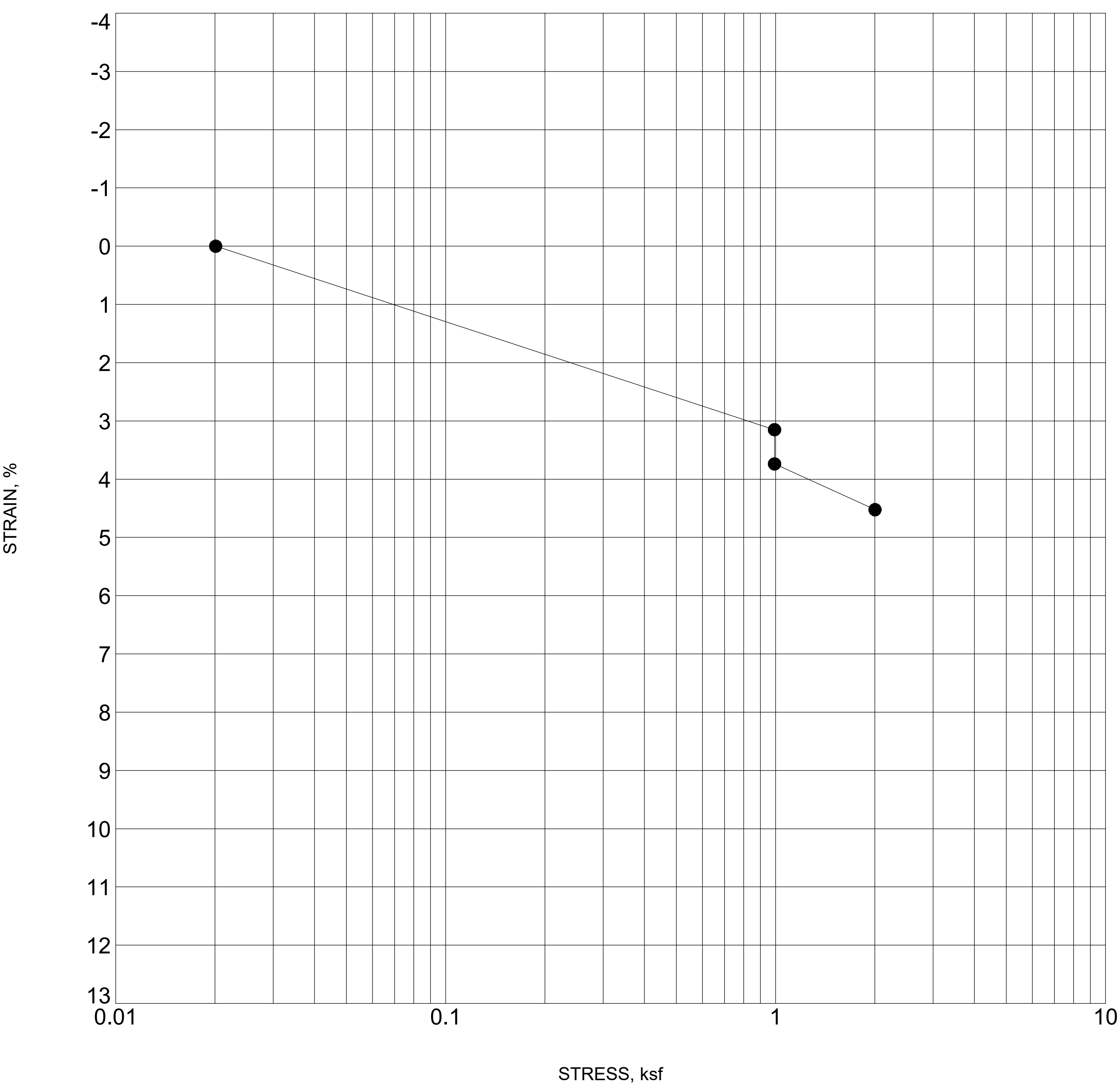
RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO



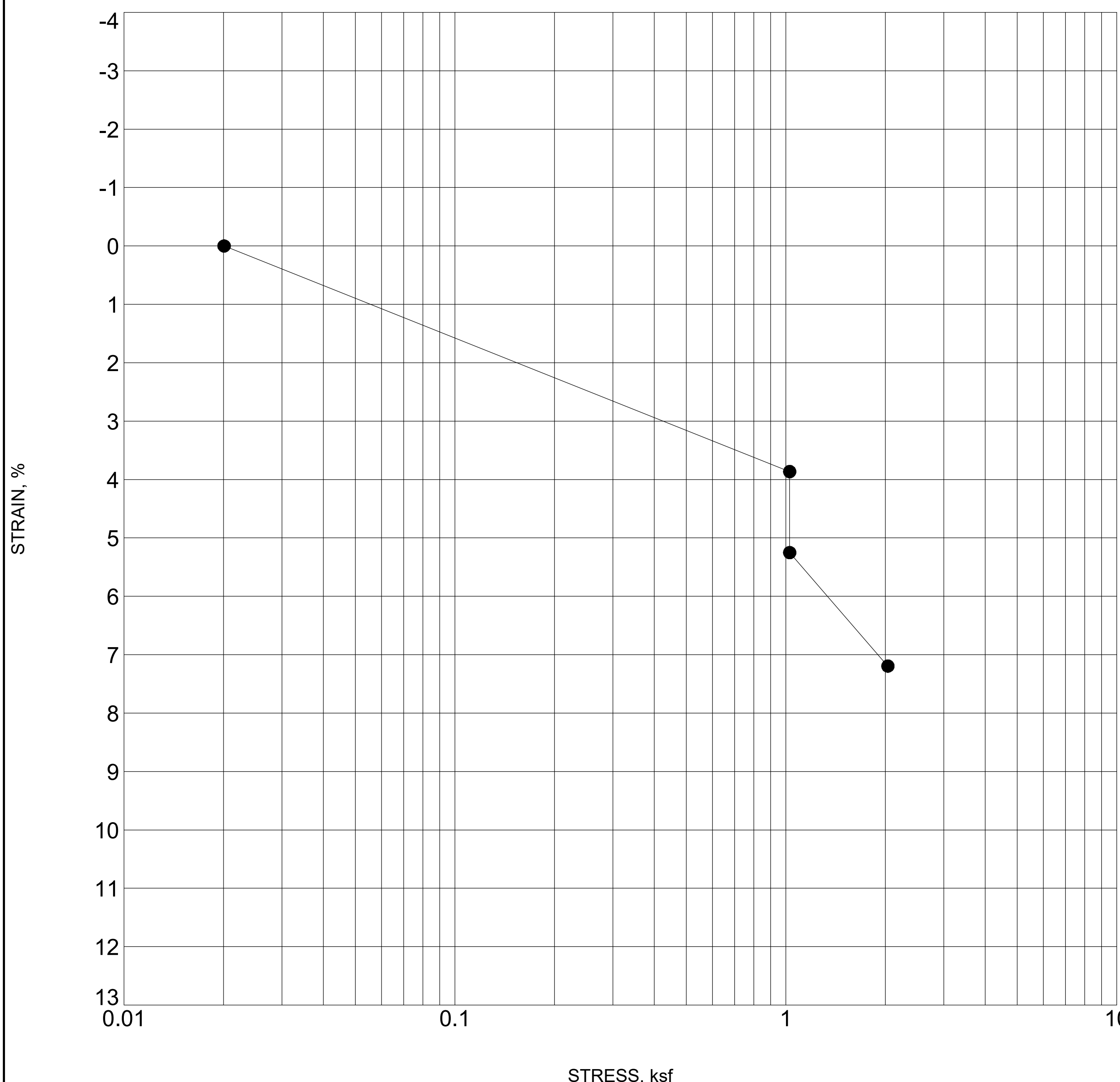
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **LC-1**	**9**	**CLAY, silty to sandy**	**-0.6**	**93.1**	**25.1**

RockSol Consulting Group, Inc.

SWELL - CONSOLIDATION TEST

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **LC-1**	**19**	**CLAY, silty to sandy**	**-1.4**	**99.2**	**24.4**

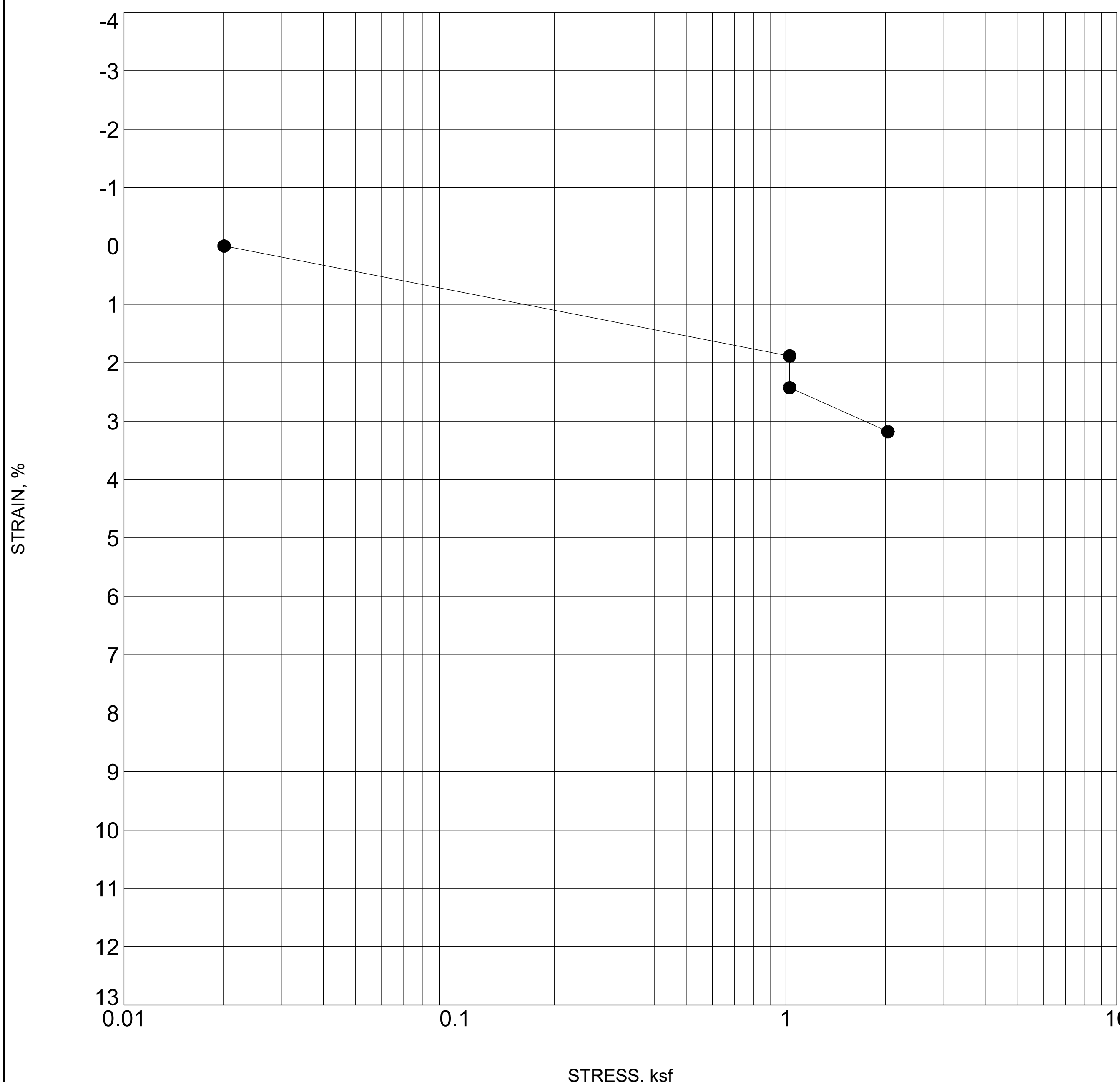
SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



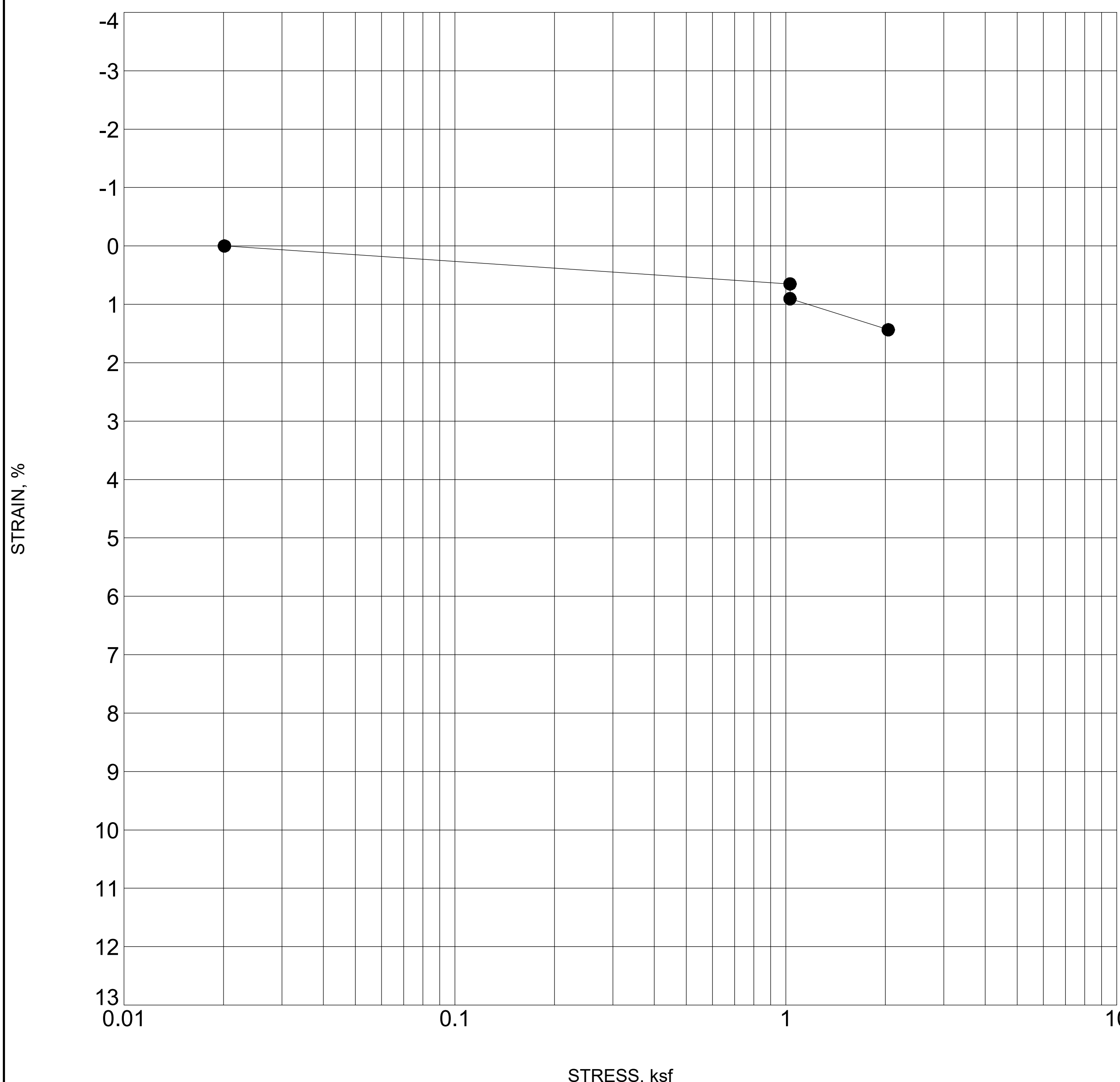
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● LC-2	4	CLAY, sandy to silty	-0.5	107.0	21.5

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO



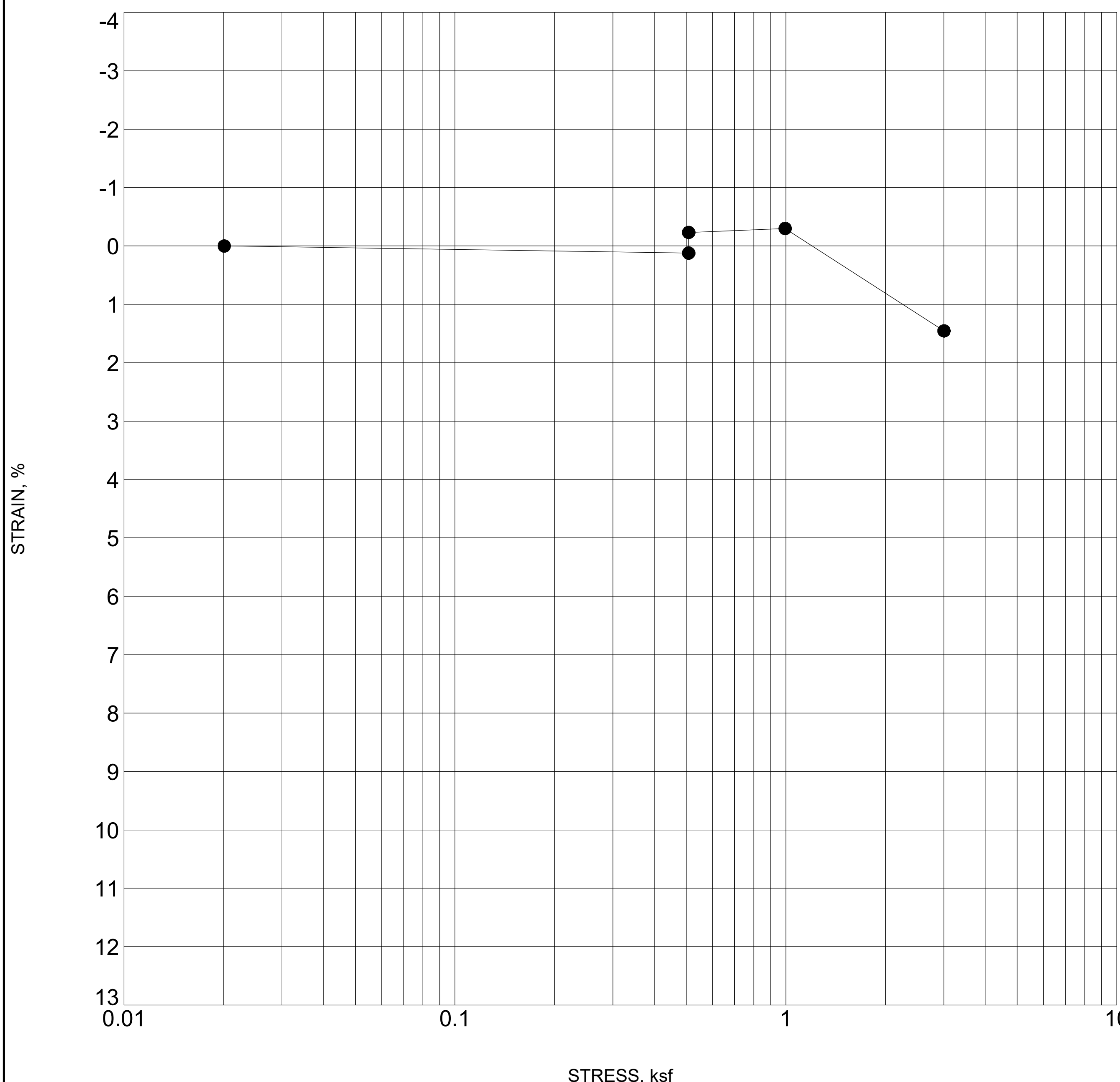
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **LC-2**	**14**	**CLAY, sandy to silty**	**-0.3**	**106.0**	**22.4**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● T-1	4	**CLAY, sandy**	**0.4**	**110.7**	**14.2**

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

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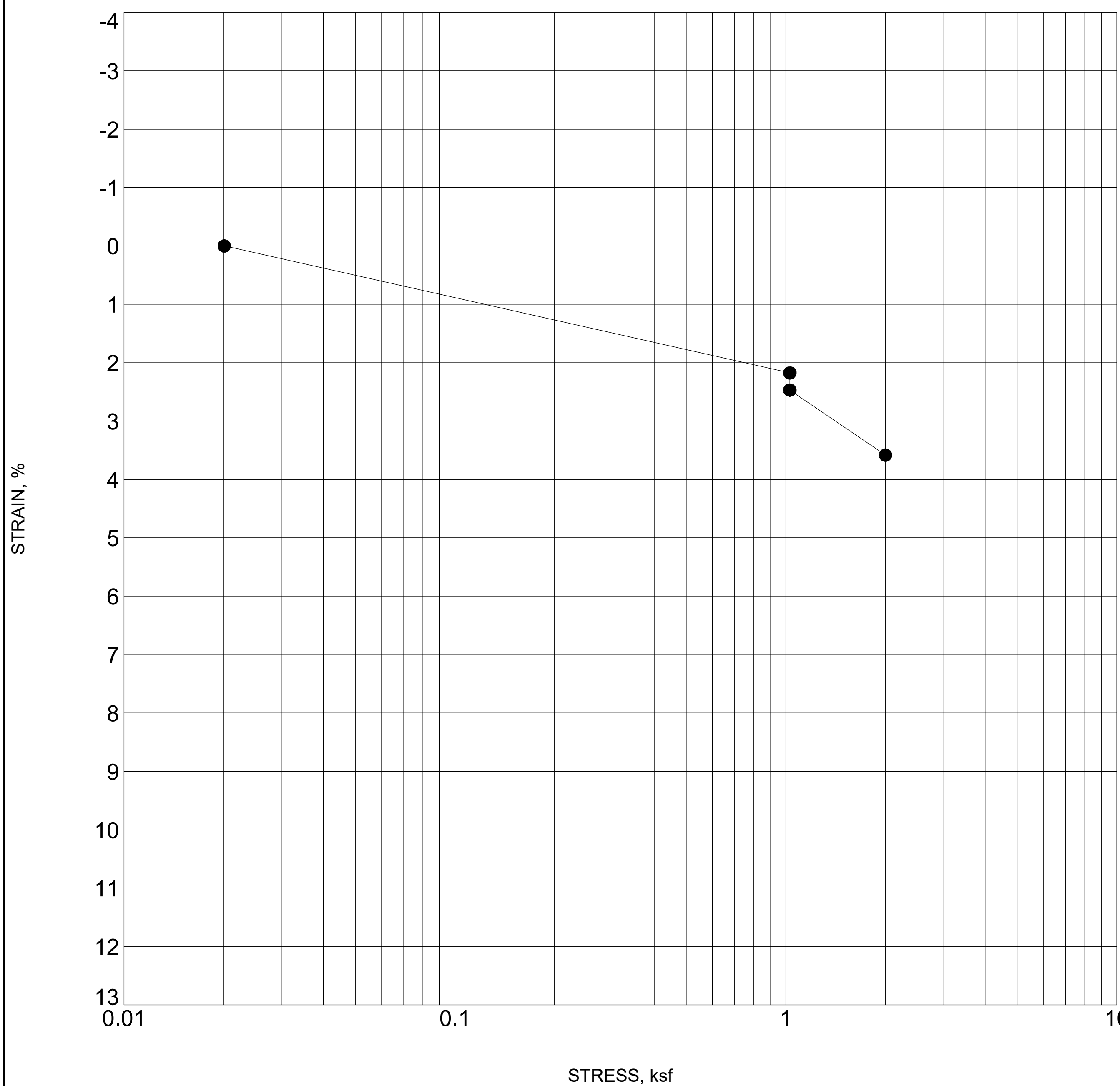
PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



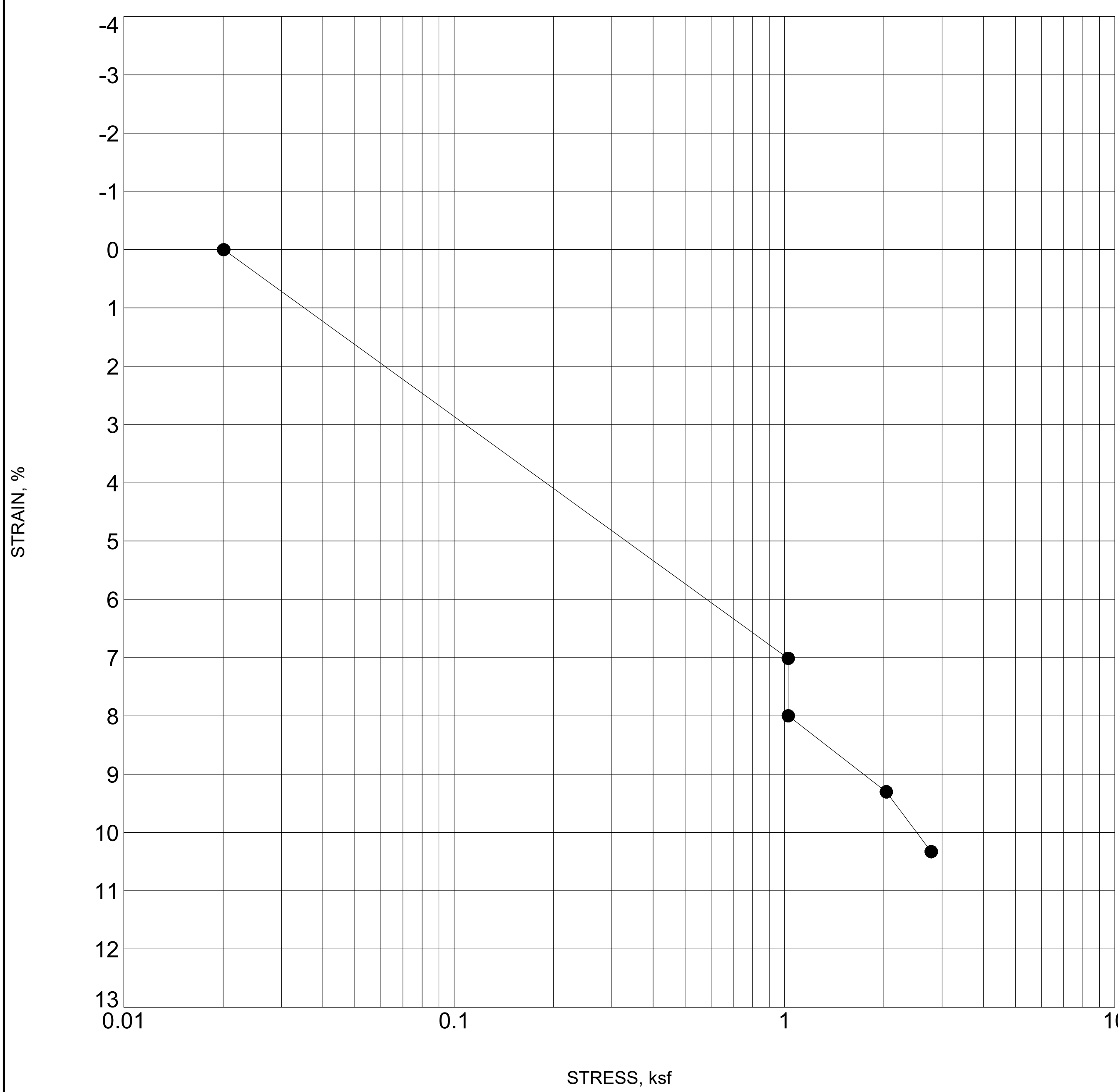
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● T-1	9	CLAY, sandy to silty w SAND lenses in parts	-0.3	98.2	26.8

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction | **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 | **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● T-2	14	CLAY, w silt and sand, SAND lenses in parts	-1.0	94.7	26.7

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

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CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

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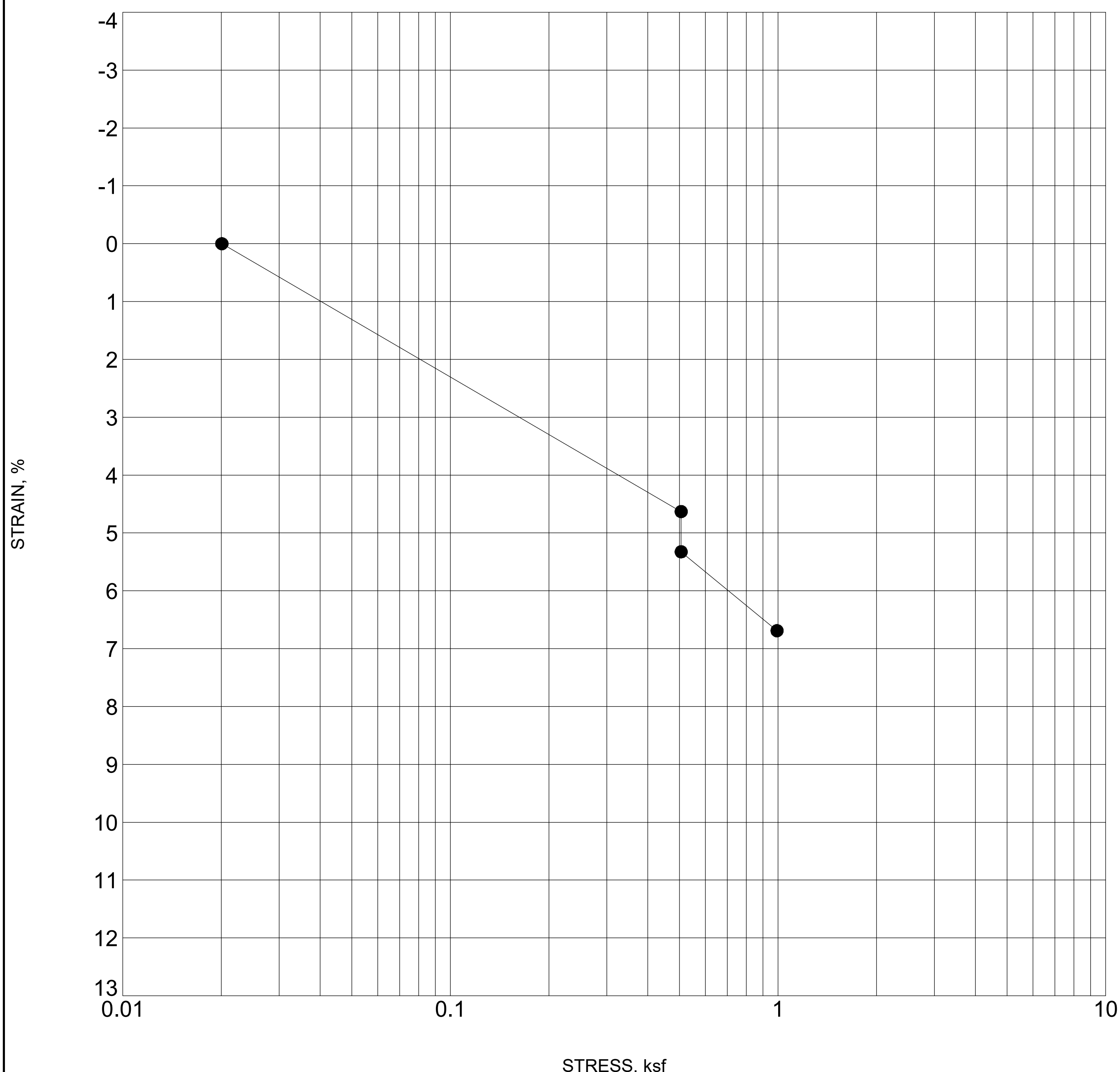
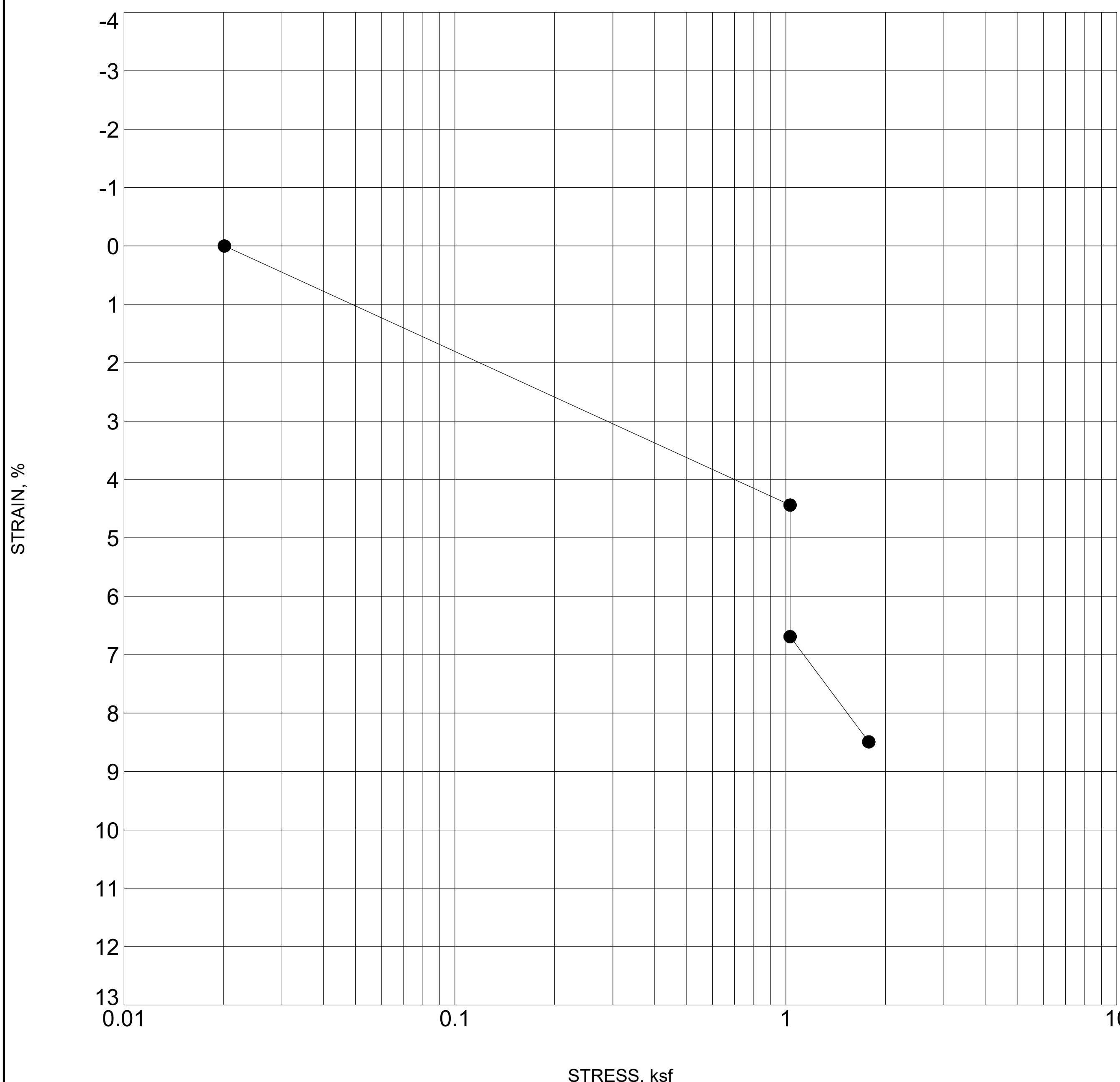


Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● T-3	4	**CLAY, silty**	**-0.7**	**97.1**	**25.2**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO



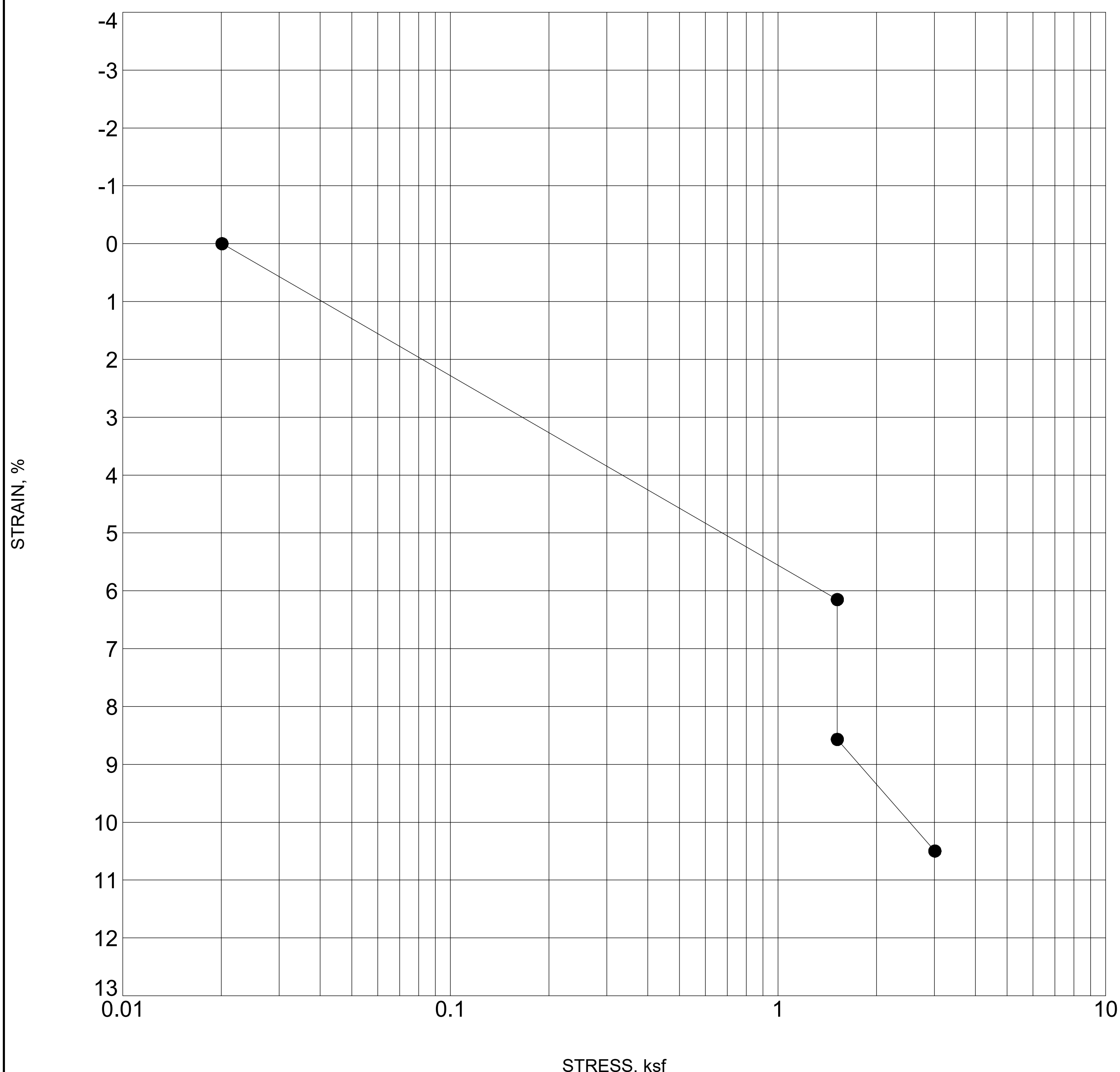
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● T-3	9	**CLAY, silty**	**-2.3**	**95.3**	**29.1**

Consulting Group, Inc.

SWELL - CONSOLIDATION TEST

CLIENT City of Grand Junction | **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 | **PROJECT LOCATION** Grand Junction, CO



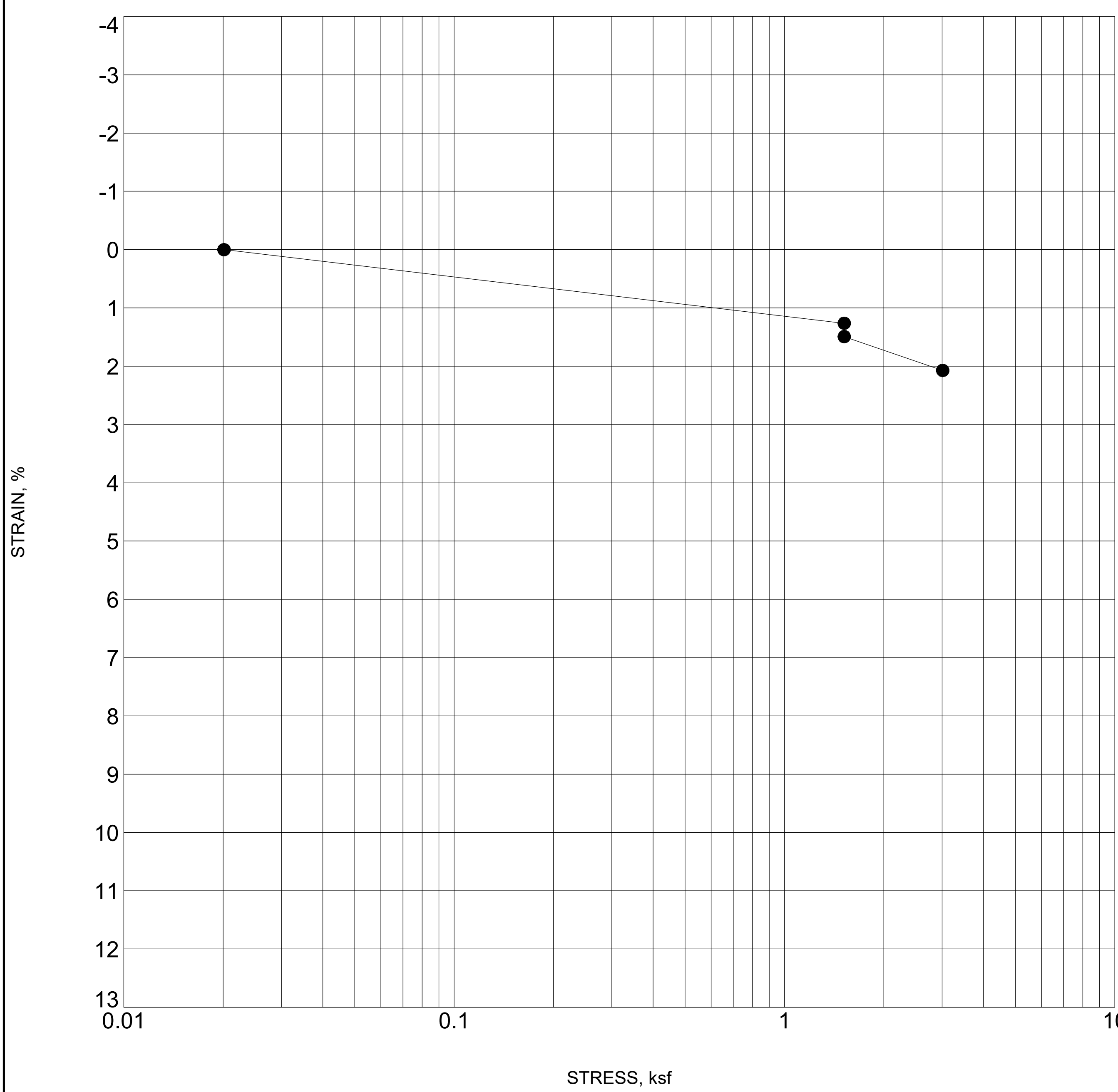
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **T-3**	**14**	**CLAY, silty**	**-2.4**	**100.1**	**25.2**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **UP-1**	**14**	**SILT, clayey**	**-0.2**	**109.4**	**23.2**

SWELL - CONSOLIDATION TEST

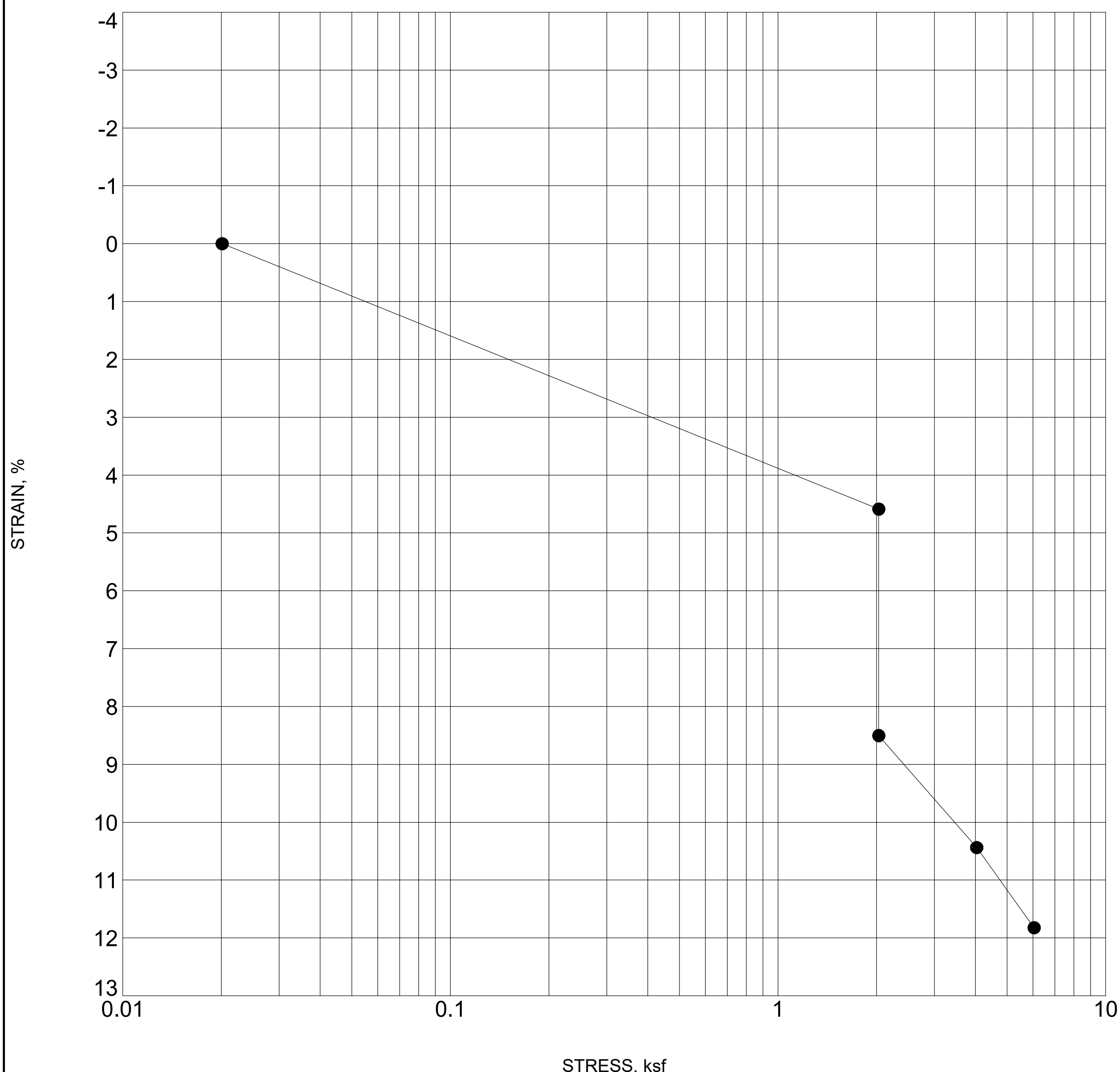
RockSol Consulting Group, Inc.

CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **UP-1**	**19**	**CLAY, silty**	**-3.9**	**97.5**	**27.8**

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

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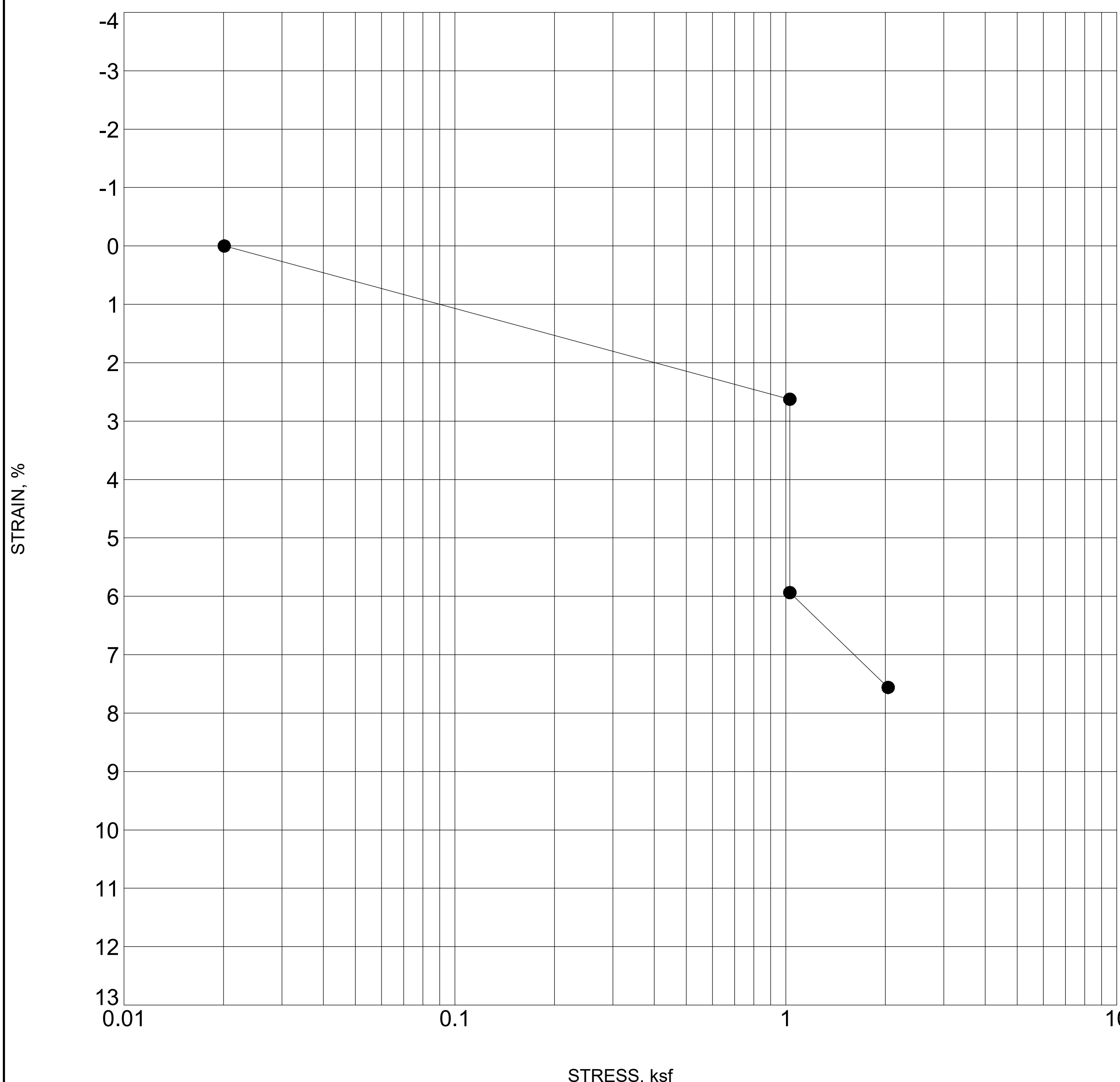
CLIENT City of Grand Junction

PROJECT NAME 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07

PROJECT LOCATION Grand Junction, CO

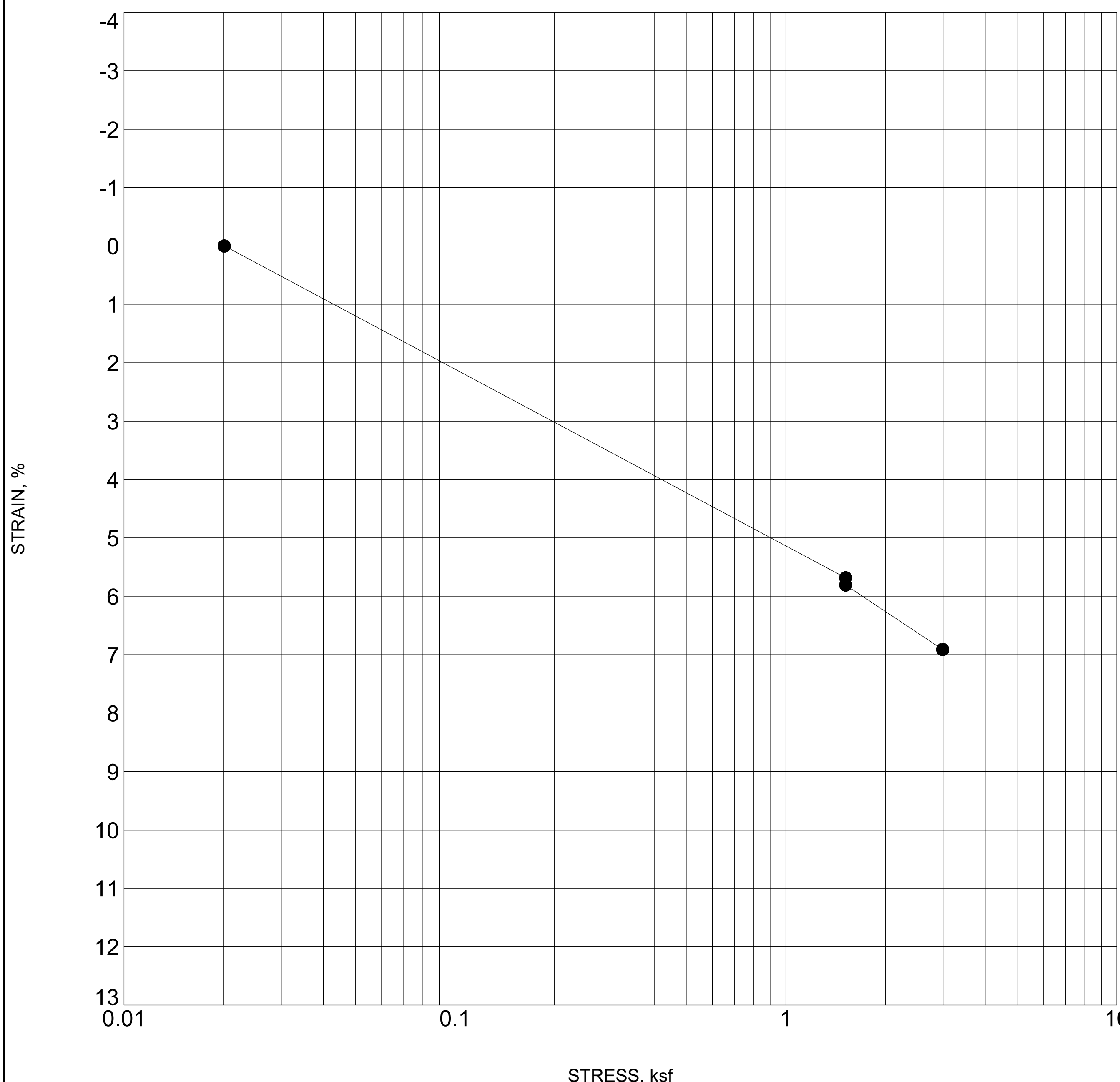


Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **UP-2**	**9**	**CLAY, silty w silty SAND lenses in parts**	**-3.3**	**100.1**	**23.0**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME 24 Rd & G Rd Improvements
PROJECT NUMBER 599.07
PROJECT LOCATION Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **UP-2**	**14**	**SAND, silty with sandy CLAY in parts**	**-0.1**	**100.5**	**26.5**

SWELL - STANDARD 599.07_24 RD & G RD IMPROVEMENTS.GPJ ROCKSOL TEMPLATE.GDT 9/17/20

SWELL - CONSOLIDATION TEST

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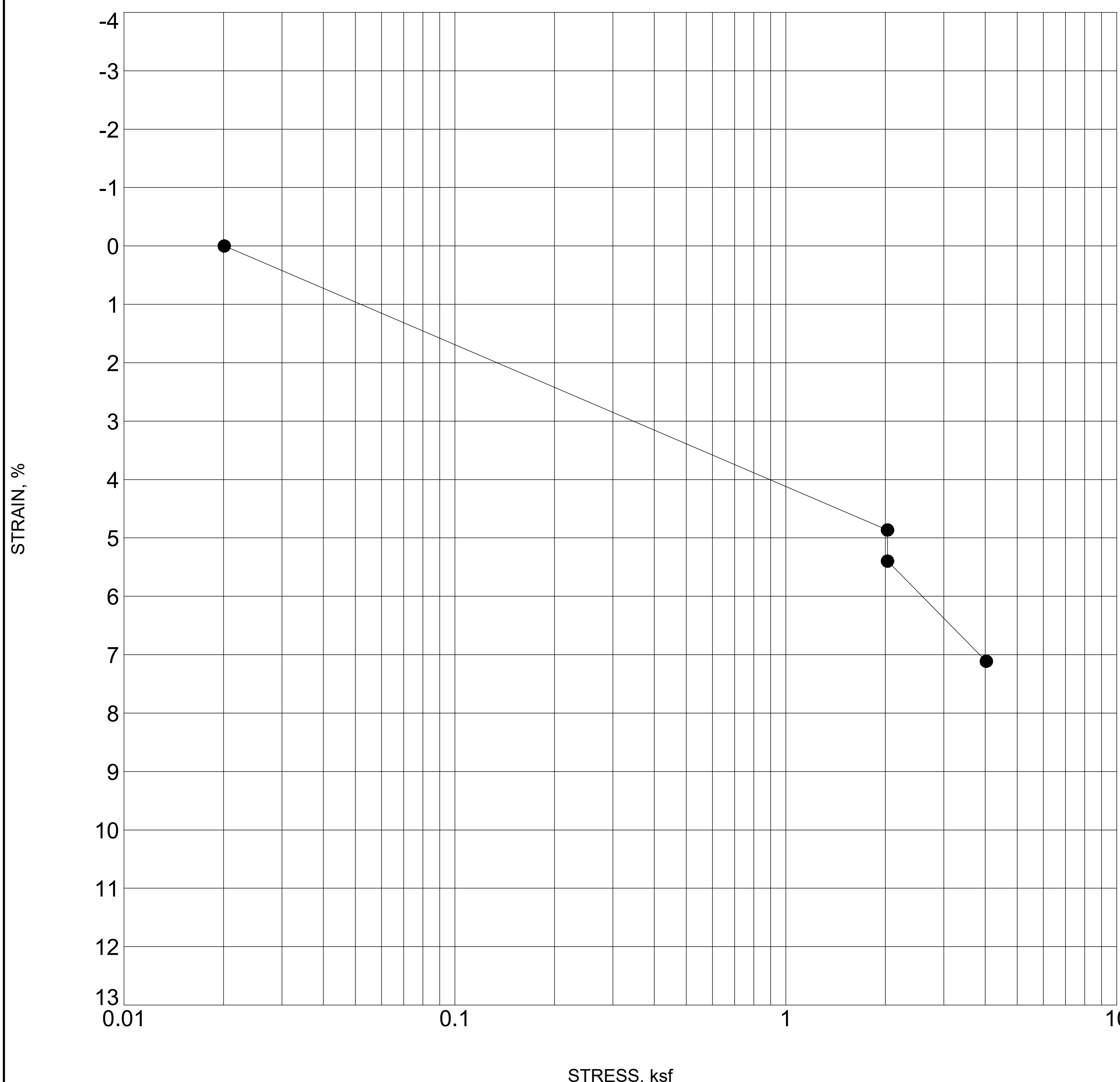
CLIENT City of Grand Junction **PROJECT NAME** 24 Rd & G Rd Improvements

PROJECT NUMBER 599.07 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **UP-2**	**19**	**CLAY, silty**	**-0.5**	**99.8**	**26.6**

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

GRADATION - SOIL AND AGGREGATE

Project Number:	20.022, RockSol Consulting	Date:	24-Jul-20
Project Name:	24 & G Road Improvements (RockSol Project No. 599.07)	Technician:	J. De Los Santos
Lab ID Number:	202879	Reviewer:	G. Hoyos
Sample Location:	Composite: 24-2, 24-3B, 24-6, and G2		
Visual Description:	CLAY, sandy, brown		

AASHTO M 145 Classification: A-4 **Group Index:**

Unified Soil Classification System (ASTM D 2487): **(CL)** **Lean clay with sand**

Sieve Analysis (ASTM C 136 & AASHTO T 27)					-#200 Wash (D 1140, C 117 & T 11)	
sieve size	accum. mass, g	% retained	% passing	*Criteria*	dish ID	B
2"					dish mass, g	161.7
1.5"					wet soil bef. wash + dish, g	596.4
1"					dry soil bef. wash + dish, g	582.6
3/4"					dry soil aft. wash + dish, g	287.1
1/2"					**-#200, %**	**70.2**
3/8"					**Moisture Content**	
#4	0.0	0.0	**100**		dish ID	E
#8					mass. of dish, g	176.1
#10	12.6	3.0	**97**		wet soil + dish, g	813.6
#16	14.3	3.4	**97**		dry soil + dish, g	793.4
#30					**Moisture Content (%)**	**3.3**
#40	28.5	6.8	**93**		**Atterberg Limits (D 4318 & T 89/T90)**	
#50	37.6	8.9	**91**		Liquid Limit (LL)	**24**
#100	69.4	16.5	**84**		Plastic Limit (PL)	15
#200	117.1	27.8	**72.2**		**Plasticity Index (PI)**	**9**
Total	420.9	grams			**Criteria:** **LL**	
Pan	125.3				**PI**	

Split Gradation Sample Mass				Remarks:
	wet	dry	%	
Total Mass, g				
+#4 Mass, g				
-#4 Mass, g				

In-Situ Density (Unit Weight)					
diameter, in.		height (in.)		sample mass, g	
diameter, in.		height (in.)		sample moisture content, %	**3.3**
diameter, in.		height (in.)		dry sample mass, g	
diameter, in.		height (in.)		wet density (unit weight), pcf	
avg. diameter		**avg. height**		**in-situ dry density (unit weight), pcf**	

Corporate: 7108 South Alton Way, Building B • Centennial, Colorado 80112
Phone 303-220-0300 • www.cesareinc.com

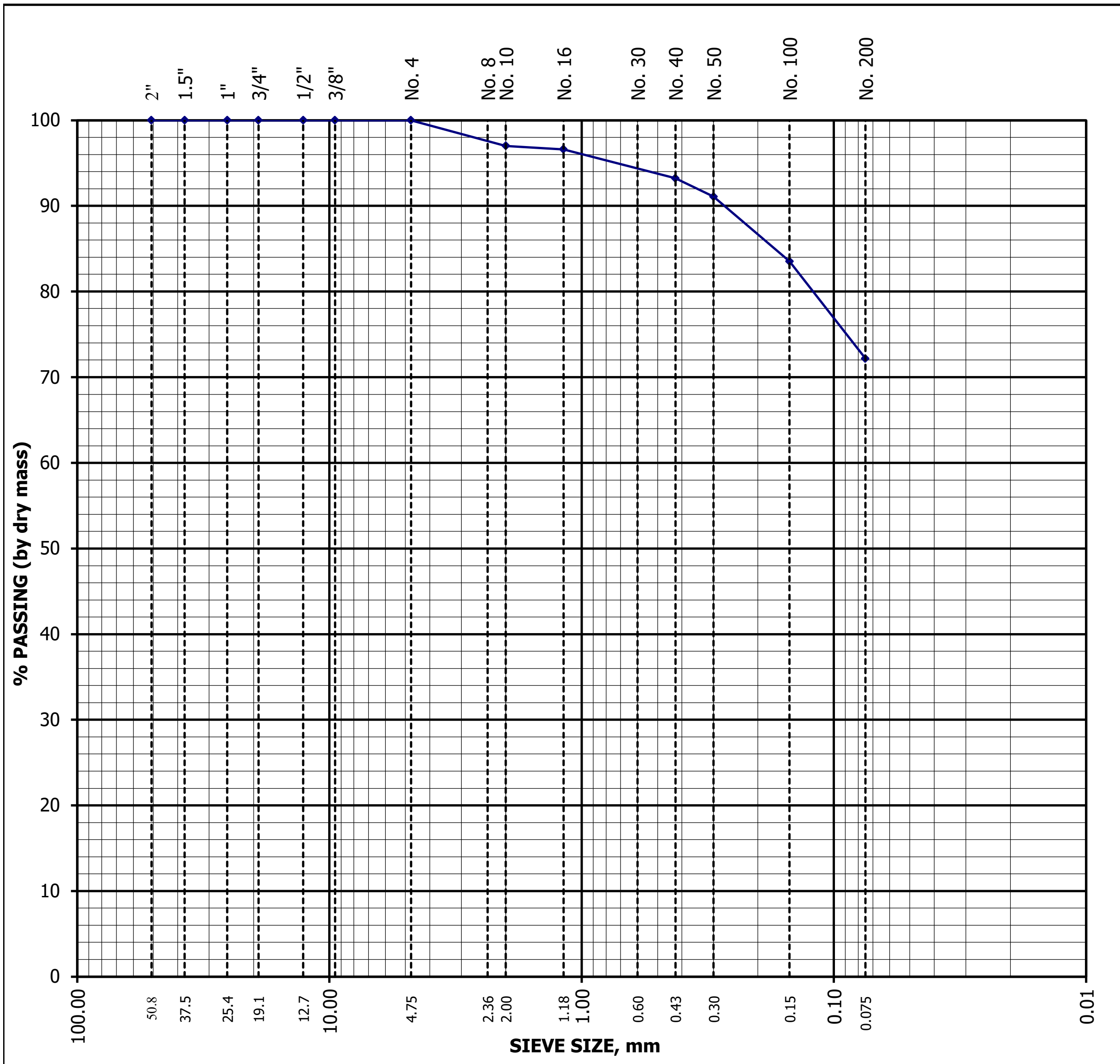
CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

GRADATION PLOT - SOIL & AGGREGATE

Project Number:	20.022, RockSol Consulting	Date:	24-Jul-20
Project Name:	24 & G Road Improvements (RockSol Project No. 599.07)	Technician:	J. De Los Santos
Lab ID Number:	202879	Reviewer:	G. Hoyos
Sample Location:	Composite: 24-2, 24-3B, 24-6, and G2		
Visual Description:	CLAY, sandy, brown		

AASHTO M 145 Classification: **A-4** **Group Index:**

Unified Soil Classification System (ASTM D 2487): **(CL)** **Lean clay with sand**



Sieve Size	% Passing
2"	
1.5"	
1"	
3/4"	
1/2"	
3/8"	
#4	100
#8	
#10	97
#16	97
#30	
#40	93
#50	91
#100	84
#200	72.2

Moisture (M) & Density (D)	
M, %:	3.3
D, pcf:	

LL	24
PL	15
PI	9

D_{60}	
D_{30}	
D_{10}	
Cu	
Cc	

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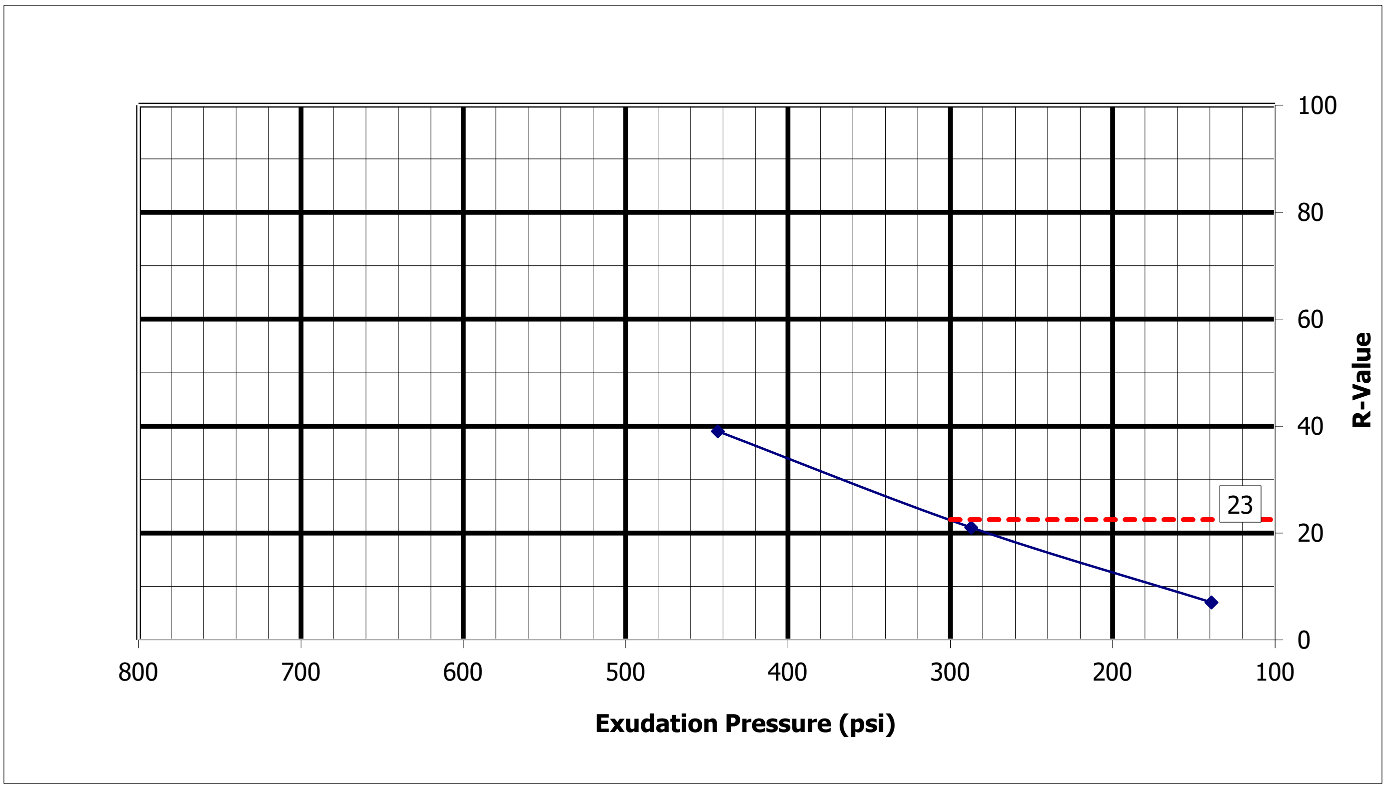
CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

AASHTO ACCREDITED

R-VALUE TEST GRAPH (AASHTO T190)

Project Number:	20.022, RockSol Consulting	Date:	27-Jul-20
Project Name:	24 & G Road Improvements (RockSol Project No. 599.07)	Technician:	G. Hoyos
Lab ID Number:	202879	Reviewer:	G. Hoyos
Sample Location:	Composite: 24-2, 24-3B, 24-6, and G2		
Visual Description:	CLAY, sandy, brown		



R-Value @ Exudation Pressure 300 psi:	**23**
Specification:	

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

$S_1 = [(R-5)/11.29]+3$ **S_1 = 4.55**

$M_R = 10^{[(S_1+18.72)/6.24]}$ **M_R = 5,360**

M_R = Resilient Modulus, psi

S_1 = the Soil Support Value

R = the R-Value obtained

Test Specimen:	1	2	3
Moisture Content, %:	11.7	14.0	16.0
Expansion Pressure, psi:	0.76	0.49	-0.03
Dry Density, pcf:	120.7	118.6	115.5
R-Value:	39	21	7
Exudation Pressure, psi:	443	287	139

Note: The R-Value is measured; the M_R is an approximation from correlation formulas.

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APPENDIX C

PAVEMENT DESIGN OUTPUT SHEETS – 24 ROAD AND G ROAD ROUNDABOUT

Initial Values

Initial Serviceability Index=	4.5
Final Serviceability Index=	2.5
Overall Standard Deviation, So=	0.44
Reliability, R (percent)=	90
Standard Normal Deviate (ZR)=	-1.282
Structural Coefficient of HMA=	0.44
Structural Coefficient of ABC=	0.11
Design Life ESALs=	9790943
R-Value=	20

Intermediate Calcs

Calculated Mr=	4940	
Design Mr=	4195	(substitute into E if necessary)
Design Serviceability Loss (ΔPSI)=	2	
A=	-0.56	
B=	7.53	
C=	-0.20	
D=	-0.28	
E=	0.50	

Final Calcs

SN=	5.3768	(use: Data > What-If Analysis > Goal Seek)	
Such That:			
Log_{10}ESAL	≤	Thickness Equation	
6.9908	≤	6.9908	
Full HMA:			
Depth=	12.22	in	
HMA over ABC:			
Depth ABC=	8	in	
Depth HMA=	10.22	in	

Roundabout	
Total Traffic	35064
Car	29804
Single Unit	4558
Heavy	702
Daily ESALs Car	89.412
Daily ESALS Single Unit	1134.942
Daily ESALs Heavy	763.074
Total ESALs	1987
Design Period Total ESALs	21757650
Design Lane ESAL's	9790943

(Use CDOT Pavement Design 2012, Section 1)

Table 1.4 Reliability and Standard Normal Deviate

Reliability, R (percent)	Standard Normal Deviate(Z_R)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
98	-2.054

$$\log_{10}(W_{18}) = Z_R S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40+\frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10} M_R - 8.07$$

Initial Values

Initial Serviceability Index=	4.5
Final Serviceability Index=	2.5
Overall Standard Deviation, So=	0.44
Reliability, R (percent)=	90
Standard Normal Deviate (ZR)=	-1.282
Structural Coefficient of HMA=	0.44
Structural Coefficient of ABC=	0.12
Structural Coefficient of Subbase=	0.11
Design Life ESALs=	9790943
R-Value=	20

Intermediate Calcs

Calculated Mr=	4940	
Design Mr=	4195	(substitute into E if necessary)
Design Serviceability Loss (ΔPSI)=	2	
A=	-0.56	
B=	7.53	
C=	-0.20	
D=	-0.28	
E=	0.50	

Final Calcs

SN=	5.3768	(use: Data > What-If Analysis > Goal Seek)
	Such That:	
Log_{10}ESAL	≤	Thickness Equation
6.9908	≤	6.9908
Full HMA:		
Depth=	12.22	in
HMA over ABC:		
Depth Subbase=	16	in
Depth ABC=	8	in
Depth HMA=	6.04	in

Roundabout

Total Traffic	35064
Car	29804
Single Unit	4558
Heavy	702
Daily ESALs Car	89.412
Daily ESALS Single Unit	1134.942
Daily ESALs Heavy	763.074
Total ESALs	1987
Design Period Total ESALs	21757650
Design Lane ESAL's	9790943

(Use CDOT Pavement Design 2012, Section 1)

Table 1.4 Reliability and Standard Normal Deviate

Reliability, R (percent)	Standard Normal Deviate(Z_R)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
98	-2.054

$$\log_{10}(W_{18}) = Z_R S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40+\frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10} M_R - 8.07$$

Rigid Pavement Design - Based on AASHTO Supplemental Guide

Reference: *LTPP DATA ANALYSIS - Phase I: Validation of Guidelines for k-Value Selection and Concrete Pavement Performance Prediction*

I. General

Agency: RockSol Consulting Group, Inc.
Street Address: 12076 Grant Street
City: Thornton
State: Colorado

Project Number: 599.07

ID:

Description: 24 Road and G Road Roundabout

Location: Grand Junction, CO

II. Design

Serviceability

Initial Serviceability, P1:	4.5
Terminal Serviceability, P2:	2.5

PCC Properties

28-day Mean Modulus of Rupture, $(S'_c)'$:	650	psi
Elastic Modulus of Slab, E_c:	3,400,000	psi
Poisson's Ratio for Concrete, m:	0.15	

Base Properties

Elastic Modulus of Base, E_b:	25,000	psi
Design Thickness of Base, H_b:	8.0	in
Slab-Base Friction Factor, f:	1.4	

Reliability and Standard Deviation

Reliability Level (R):	90.0	%
Overall Standard Deviation, S_0:	0.34	

Climatic Properties

Mean Annual Wind Speed, WIND:	8.8	mph
Mean Annual Air Temperature, TEMP:	50.3	^{o}F
Mean Annual Precipitation, PRECIP:	8.3	in

Subgrade k-Value

150 psi/in

Design ESALs

9.8 million

Pavement Type, Joint Spacing (L)

- (●) JPCP
- ( ) JRCP
- ( ) CRCP

Joint Spacing: 12.0 ft

JPCP

Effective Joint Spacing: 144 in

Edge Support

- ( ) Conventional 12-ft wide traffic lane
- (●) Conventional 12-ft wide traffic lane + tied PCC
- ( ) 2-ft widened slab w/conventional 12-ft traffic lane

Edge Support Factor: 0.94

Sensitivity Analysis

Slab Thickness used for Sensitivity Analysis: 8.98 in

- ( ) Modulus of Rupture
- ( ) Elastic Modulus (Slab)
- ( ) Elastic Modulus (Base)
- ( ) Base Thickness
- (●) k-Value
- ( ) Joint Spacing
- ( ) Reliability
- ( ) Standard Deviation

Calculated Slab Thickness for Above Inputs: 8.98 in

APPENDIX D

PAVEMENT DESIGN OUTPUT SHEETS – 24 ROAD

Initial Values

Initial Serviceability Index=	4.5
Final Serviceability Index=	2.5
Overall Standard Deviation, So=	0.44
Reliability, R (percent)=	90
Standard Normal Deviate (ZR)=	-1.282
Structural Coefficient of HMA=	0.44
Structural Coefficient of ABC=	0.11
Design Life ESALs=	6494445
R-Value=	20

Intermediate Calcs

Calculated Mr=	4940	
Design Mr=	4195	(substitute into E if necessary)
Design Serviceability Loss (ΔPSI)=	2	
A=	-0.56	
B=	7.34	
C=	-0.20	
D=	-0.26	
E=	0.50	

Final Calcs

SN= 5.0864 (use: Data > What-If Analysis > Goal Seek)

Such That:

$\log_{10}$ESAL	≤	Thickness Equation
6.8125	≤	6.8125

Full HMA:

Depth= 11.56 in

HMA over ABC:

Depth ABC= 8 in

Depth HMA= 9.56 in

24 Rd

Total Traffic	23256
Car	19768
Single Unit	3023
Heavy	465
Daily ESALs Car	59.3028
Daily ESALS Single Unit	752.7967
Daily ESALs Heavy	505.5854
Total ESALs	1318
Design Period Total ESALs	14432100
Design Lane ESAL's	6494445

(Use CDOT Pavement Design 2012, Section 1)

Table 1.4 Reliability and Standard Normal Deviate

Reliability, R (percent)	Standard Normal Deviate(Z_R)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
98	-2.054

$$\log_{10}(W_{18}) = Z_R S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40+\frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10} M_R - 8.07$$

Initial Values

Initial Serviceability Index=	4.5
Final Serviceability Index=	2.5
Overall Standard Deviation, So=	0.44
Reliability, R (percent)=	90
Standard Normal Deviate (ZR)=	-1.282
Structural Coefficient of HMA=	0.44
Structural Coefficient of ABC=	0.12
Structural Coefficient of Subbase=	0.11
Design Life ESALs=	6494445
R-Value=	20

Intermediate Calcs

Calculated Mr=	4940	
Design Mr=	4195	(substitute into E if necessary)
Design Serviceability Loss (ΔPSI)=	2	
A=	-0.56	
B=	7.34	
C=	-0.20	
D=	-0.26	
E=	0.50	

Final Calcs

SN= 5.0864 (use: Data > What-If Analysis > Goal Seek)

Such That:

$Log_{10}ESAL$	≤	Thickness Equation
6.8125	≤	6.8125

Full HMA:

Depth= 11.56 in

HMA over ABC:

Depth Subbase=	14	in
Depth ABC=	8	in
Depth HMA=	5.88	in

24 Rd

Total Traffic	23256
Car	19768
Single Unit	3023
Heavy	465
Daily ESALs Car	59.3028
Daily ESALS Single Unit	752.7967
Daily ESALs Heavy	505.5854
Total ESALs	1318
Design Period Total ESALs	14432100
Design Lane ESAL's	6494445

(Use CDOT Pavement Design 2012, Section 1)

Table 1.4 Reliability and Standard Normal Deviate

Reliability, R (percent)	Standard Normal Deviate(Z_R)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
98	-2.054

$$\log_{10}(W_{18}) = Z_R S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40+\frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10} M_R - 8.07$$

Rigid Pavement Design - Based on AASHTO Supplemental Guide

Reference: *LTPP DATA ANALYSIS - Phase I: Validation of Guidelines for k-Value Selection and Concrete Pavement Performance Prediction*

I. General

Agency: RockSol Consulting Group, Inc.
Street Address: 12076 Grant Street
City: Thornton
State: Colorado

Project Number: 599.07

ID:

Description: 24 Road

Location: Grand Junction, CO

II. Design

Serviceability

Initial Serviceability, P1: 4.5
Terminal Serviceability, P2: 2.5

PCC Properties

28-day Mean Modulus of Rupture, $(S'_c)'$: 650 psi
Elastic Modulus of Slab, E_c: 3,400,000 psi
Poisson's Ratio for Concrete, m: 0.15

Base Properties

Elastic Modulus of Base, E_b: 25,000 psi
Design Thickness of Base, H_b: 8.0 in
Slab-Base Friction Factor, f: 1.4

Reliability and Standard Deviation

Reliability Level (R): 90.0 %
Overall Standard Deviation, S_0: 0.34

Climatic Properties

Mean Annual Wind Speed, WIND: 8.8 mph
Mean Annual Air Temperature, TEMP: 50.3 ^{o}F
Mean Annual Precipitation, PRECIP: 8.3 in

Subgrade k-Value

150 psi/in

Design ESALs

6.5 million

Pavement Type, Joint Spacing (L)

- (●) JPCP
- ( ) JRCP
- ( ) CRCP

Joint Spacing: 12.0 ft

JPCP

Effective Joint Spacing: 144 in

Edge Support

- ( ) Conventional 12-ft wide traffic lane
- (●) Conventional 12-ft wide traffic lane + tied PCC
- ( ) 2-ft widened slab w/conventional 12-ft traffic lane

Edge Support Factor: 0.94

Sensitivity Analysis

Slab Thickness used for Sensitivity Analysis: 8.36 in

- ( ) Modulus of Rupture
- ( ) Elastic Modulus (Slab)
- ( ) Elastic Modulus (Base)
- ( ) Base Thickness
- (●) k-Value
- ( ) Joint Spacing
- ( ) Reliability
- ( ) Standard Deviation

Calculated Slab Thickness for Above Inputs: 8.36 in

APPENDIX E

PAVEMENT DESIGN OUTPUT SHEETS – G ROAD

Initial Values

Initial Serviceability Index=	4.5
Final Serviceability Index=	2.5
Overall Standard Deviation, So=	0.44
Reliability, R (percent)=	90
Standard Normal Deviate (ZR)=	-1.282
Structural Coefficient of HMA=	0.44
Structural Coefficient of ABC=	0.11
Design Life ESALs=	3296498
R-Value=	20

(Use CDOT Pavement Design 2012, Section 1)

Table 1.4 Reliability and Standard Normal Deviate

Reliability, R (percent)	Standard Normal Deviate(Z_R)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
98	-2.054

Intermediate Calcs

Calculated Mr=	4940	
Design Mr=	4195	(substitute into E if necessary)
Design Serviceability Loss (ΔPSI)=	2	
A=	-0.56	
B=	7.02	
C=	-0.20	
D=	-0.24	
E=	0.50	

$$\log_{10}(W_{18}) = Z_R S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40+\frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10}M_R - 8.07$$

Final Calcs

SN= 4.6298 (use: Data > What-If Analysis > Goal Seek)

Such That:

$\log_{10}$ESAL		Thickness Equation
6.5181	≤	6.5182

Full HMA:

Depth= 10.52 in

HMA over ABC:

Depth ABC= 8 in

Depth HMA= 8.52 in

G Rd

Total Traffic	11808
Car	10037
Single Unit	1535
Heavy	236
Daily ESALs Car	30.1104
Daily ESALS Single Unit	382.225
Daily ESALs Heavy	256.7059
Total ESALs	669
Design Period Total ESALs	7325550
Design Lane ESAL's	3296498

Initial Values

Initial Serviceability Index=	4.5
Final Serviceability Index=	2.5
Overall Standard Deviation, So=	0.44
Reliability, R (percent)=	90
Standard Normal Deviate (ZR)=	-1.282
Structural Coefficient of HMA=	0.44
Structural Coefficient of ABC=	0.12
Structural Coefficient of Subbase=	0.11
Design Life ESALs=	3296498
R-Value=	20

Intermediate Calcs

Calculated Mr=	4940	
Design Mr=	4195	(substitute into E if necessary)
Design Serviceability Loss (ΔPSI)=	2	
A=	-0.56	
B=	7.02	
C=	-0.20	
D=	-0.24	
E=	0.50	

Final Calcs

SN= 4.6298 (use: Data > What-If Analysis > Goal Seek)

Such That:

$Log_{10}ESAL$	≤	Thickness Equation
6.5181	≤	6.5182

Full HMA:

Depth= 10.52 in

HMA over ABC:

Depth Subbase=	10	in
Depth ABC=	8	in
Depth HMA=	5.84	in

G Rd

Total Traffic	11808
Car	10037
Single Unit	1535
Heavy	236
Daily ESALs Car	30.1104
Daily ESALS Single Unit	382.225
Daily ESALs Heavy	256.7059
Total ESALs	669
Design Period Total ESALs	7325550
Design Lane ESAL's	3296498

(Use CDOT Pavement Design 2012, Section 1)

Table 1.4 Reliability and Standard Normal Deviate

Reliability, R (percent)	Standard Normal Deviate(Z_R)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
98	-2.054

$$\log_{10}(W_{18}) = Z_R S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40+\frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10} M_R - 8.07$$

Rigid Pavement Design - Based on AASHTO Supplemental Guide

Reference: *LTPP DATA ANALYSIS - Phase I: Validation of Guidelines for k-Value Selection and Concrete Pavement Performance Prediction*

I. General

Agency: RockSol Consulting Group, Inc.
Street Address: 12076 Grant Street
City: Thornton
State: Colorado

Project Number: 599.07

ID:

Description: G Road

Location: Grand Junction, CO

II. Design

Serviceability

Initial Serviceability, P1: 4.5
Terminal Serviceability, P2: 2.5

PCC Properties

28-day Mean Modulus of Rupture, $(S'_c)'$: 650 psi
Elastic Modulus of Slab, E_c: 3,400,000 psi
Poisson's Ratio for Concrete, m: 0.15

Base Properties

Elastic Modulus of Base, E_b: 25,000 psi
Design Thickness of Base, H_b: 8.0 in
Slab-Base Friction Factor, f: 1.4

Reliability and Standard Deviation

Reliability Level (R): 90.0 %
Overall Standard Deviation, S_0: 0.34

Climatic Properties

Mean Annual Wind Speed, WIND: 8.8 mph
Mean Annual Air Temperature, TEMP: 50.3 ^oF
Mean Annual Precipitation, PRECIP: 8.3 in

Subgrade k-Value

150 psi/in

Design ESALs

3.3 million

Pavement Type, Joint Spacing (L)

- (●) JPCP
- ( ) JRCP
- ( ) CRCP

Joint Spacing: 12.0 ft

JPCP

Effective Joint Spacing: 144 in

Edge Support

- ( ) Conventional 12-ft wide traffic lane
- (●) Conventional 12-ft wide traffic lane + tied PCC
- ( ) 2-ft widened slab w/conventional 12-ft traffic lane

Edge Support Factor: 0.94

Sensitivity Analysis

Slab Thickness used for Sensitivity Analysis: 7.38 in

- ( ) Modulus of Rupture
- ( ) Elastic Modulus (Slab)
- ( ) Elastic Modulus (Base)
- ( ) Base Thickness
- (●) k-Value
- ( ) Joint Spacing
- ( ) Reliability
- ( ) Standard Deviation

Calculated Slab Thickness for Above Inputs: 7.38 in